PUBLIC WORKS

City, County and State

SEP 1

Norfolk Street, Simcoe, Ontario, Canada. Tarvia-built in 1919. The upper photo was taken in 1921; the lower shows the condition of Norfolk Street today. The contrast in traffic conditions shows the change in urban life during the past fifteen years . . . a change made possible by good roads.

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SEPTEMBER 1934

September 1934

PUBLIC WORKS

Vol. 65 No. 9

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TIMEWASTERS

In response to our pyramid problem in the August issue, Major F. E. Daniels sends us a box of nice wooden blocks all cut out to the proper bevel (so he says). As to the problem, he says it isn't any problem at all. "Just put it on the saw, and it comes right out, and it can't help but fit." Maybe so, Brer Daniels, but it didn't with us. Bob Clark says, anent this same problem, that, if his slide rule didn't slip, the angle of the bevel for the 45° pyramid is something like 57°. It slipped, Bob. The OK on it is 30° for the 45° pyramid, and 52° plus for the 60° pyramid. Lynne Bevan says he worked it out on a cardboard box that was conveniently handy. See page 40.

The cannonball problem wasn't so bad. There were 48 balls in the perimeter of the base of the square pyramid, 36 in the perimeter of the base of the larger triangle, and 33 in the smaller. The hill-billy problem is still worrying some of the brethren. Bob Clark writes in to correct his former answer and asserts 1/650 of an inch is OK. M. Eisner, whose solution appears on a page in the rear of this issue, stands by 1/600 of an inch. The boys are now 1/7800 of an inch apart. Near enough. Discussion is now closed on this particular headache. See page 40.

The solution to the problem of constructing a table of logs with only a compass and a straight edge is given on page 35. And now for the new business:

Call for Ed Wynn:

A 2-lane road is occupied by cars 16 feet long, traveling 20 miles an hour in each direction. Cars in both lanes are spaced at equal intervals. How long must the interval be to permit a fire truck 24 feet long to get through the traffic uniformly at 40 miles per hour, provided that the fire truck always keep 50 feet in the clear from the nearest car in the same lane? *Benjamin Eisner.*

A Scrap of Paper:

If a piece of paper is 10 inches wide, how long must it be so that, when folded double, with the fold parallel to the 10-inch side, the proportions of the folded sheet are the same as the original sheet?

The Hall-Room Problem:

In a rectangular room, 10 feet long by 5 feet wide, what is the longest plank, 1 foot wide, that can be laid flat on the floor. *R. N. Clark.*

Says Walter Wheeler:

"When Cassius J. Keyser, Adrian Professor of Mathematics and Emeritus, Columbia University, wrote 'The Humanity of Mathematics,' published in the March, 1933, issue of The American Scholar, he hardly got the kernel of the humanity part of mathematics. He should be figuring on 'Timewasters.' But to get back to 'Preparedness' and show you my cock-suredness, I want to tell you that there were 819 balls; and that was one d— nice little problem. In fact, I think that the August issue of 'Timewasters' was one of the best that I have ever seen published."

Thanks, Mr. Wheeler—*W. A. H.*

SUBSCRIPTION RATES: United States and Possessions, Mexico and Cuba, $3.00. All other countries, $4.00. Single Copies, 35 cents each.

A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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When you need catalogs—consult the *classified* READERS' SERVICE DEPT., pages 51-53.

1934

PUBLIC WORKS

City, County and State Engineering and Construction

Vol. 65 — *September, 1934* — No. 9

Studies in Water Consumption

Figures from New England municipalities for 1933-1934

During the spring of 1934, questionnaires were sent by PUBLIC WORKS *to more than 1500 cities in the United States requesting data on water consumption by months, consumption per capita per day and percentage of services metered. The present study covers some 500 cities which furnished the information in a complete form. Other cities, which were not able to give these data are omitted from the calculations. The information presented here suppplements that obtained by* PUBLIC WORKS *some two years ago covering monthly, daily and hourly maximum consumption. The figures are in most cases for the year 1933 or for 1933-1934.*

Due to the great amount of space required for a complete presentation, which is necessary if data for design are to be provided, the information will be published from time to time grouped by geographical divisions of the country. This installment pertains to New England.

INFORMATION on monthly consumption was obtained from 46 cities in New England, of which 36 were located in Massachusetts, 4 in Maine, and 2 each in Connecticut, New Hampshire and Rhode Island. Information of the percentage of services metered and the consumption per capita was also obtained from nearly all of these 46 cities.

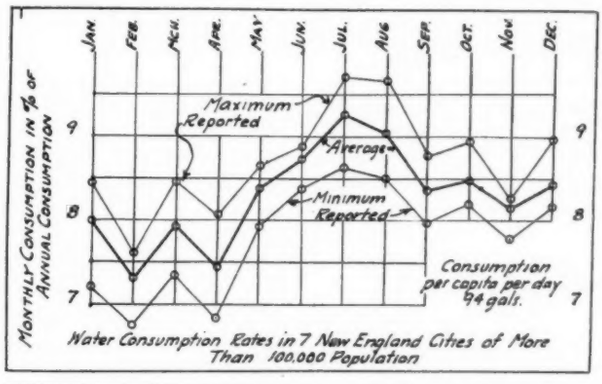
Charts herewith show the monthly consumption in per cent of the total for 7 New England cities of more than 100,000 population, and for 13 New England communities of less than 10,000 population. It will be noted that the averages of these two groups correspond quite closely, the only marked differences being in the months of April and May.

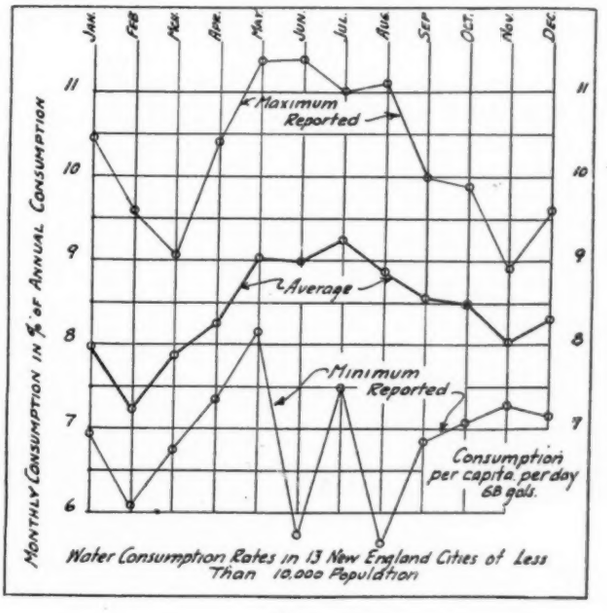
The maxima and minima consumptions, however, differ very considerably. The curves showing these are constructed by taking the least consumption and the greatest consumption reported by any municipality. In the case of the seven cities of more than 100,000 population, the maxima and minima do not represent any great departure from the average. But this is not the case with the small communities. Local conditions or characteristics are often sharply accentuated, and unusual conditions affect results in small communities much more than they do in the larger ones.

An example of this is the city of Williamstown, Mass., where extremely low consumption is reported for the months of June and August. This is a college town, and the fact that college is closed during the summer months, and the population correspondingly increased in the winter months, causes this town to be represented in either the maximum or the minimum group in 8 of the 12 months of the year. Cambridge, also a college city, but a much larger one, furnishes two maximum and two minimum figures but their departures from the averages are not so great.

Another factor that may cause marked variations in consumption, especially in these times, is that of industrial activity. Mills or industries using considerable water may operate only part time, or seasonally, and the effect will be noted in an unbalancing of consumption.

These figures give an excellent picture of the monthly variations in consumption. Their greatest use will probably be to the designer in estimating the water supplies and storage to be provided for a given community, permitting him to make comparisons with a number of communities of similar size and environmental characteristics. The information as to monthly consumption requirements can be utilized to show storage required in supply reservoirs, and capacity of pipe lines and of distribution reservoirs needed. In connection with the data given in the October, 1932, issue of PUBLIC WORKS, these may also be of value in the design of distribution systems.

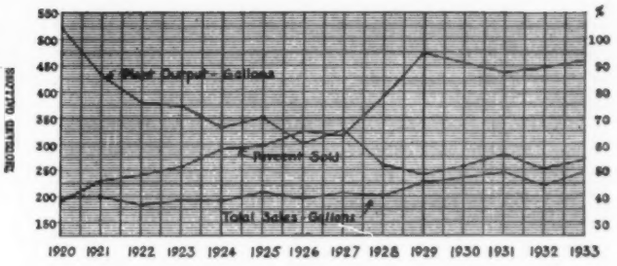




Monthly Water Consumption, in Percentage of Total Annual Consumption, in the New England States

City and State	*Population*	*Percentage of Service Metered Consumption*	*Gals. per Day per Person*	*January*	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*
Worcester, Mass.	194,000	96	66	7.58	6.90	7.52	7.17	8.15	8.87	9.70	9.65	8.77	8.50	8.17	8.96
Bridgeport, Conn.	175,000	30	128	7.56	7.06	7.71	7.57	8.31	8.80	9.51	9.29	8.63	8.79	8.22	8.58
Springfield, Mass.	150,000	100	87	8.10	7.51	7.95	7.64	8.57	8.88	9.43	8.95	8.47	8.30	7.85	8.42
Pawtucket, R. I.	130,000	98	68	8.36	7.80	7.98	7.39	8.45	8.70	9.36	9.04	8.37	8.49	7.79	8.26
New Bedford, Mass.	120,541	100	77	8.02	7.09	7.72	6.82	8.22	8.89	9.55	9.44	8.71	8.92	8.27	8.33
Cambridge, Mass.	120,000	98	92	8.43	7.48	8.45	7.88	8.70	8.55	8.61	8.80	7.97	8.57	8.25	8.39
Portland, Me.	106,000	53	126	8.26	7.60	8.45	8.07	8.64	8.67	9.03	8.50	8.11	8.20	7.96	8.42
Manchester, N. H.	78,000	97	62	8.03	7.16	7.90	7.62	8.71	9.60	9.84	8.96	8.14	8.21	7.77	7.98
Newton, Mass.	70,693	..	67	7.80	5.36	9.00	8.37	8.68	8.18	9.71	9.38	8.46	8.76	8.13	8.12
Brockton, Mass.	63,797	100	44	7.54	7.90	7.76	8.26	8.48	8.62	9.12	8.90	8.90	8.41	8.19	7.90
Holyoke, Mass.	55,590	10	127	7.58	7.06	7.66	7.44	7.90	8.95	10.27	10.15	8.49	8.40	7.97	8.06
Woonsocket, R. I.	50,000	100	60	8.17	7.36	7.55	7.18	8.14	8.72	9.80	9.88	8.72	8.86	7.98	7.83
Chicopee, Mass.	43,930	90	51	7.36	6.64	6.92	6.95	9.48	9.73	10.31	10.93	8.33	7.80	7.77	7.76
Fitchburg, Mass.	40,000	99	..	7.42	6.88	8.18	7.49	7.83	8.18	9.04	9.51	9.65	8.70	8.50	8.42
Taunton, Mass.	37,000	94	75	8.30	7.94	8.65	8.15	8.96	9.20	9.43	8.91	8.00	7.95	7.40	7.63
No. Adams, Mass.	22,612	100	94	8.15	7.41	8.06	7.75	7.68	7.87	8.02	9.21	8.92	9.10	8.95	9.06
Framingham, Mass.	22,222	100	62	8.58	7.66	8.48	7.38	8.02	8.48	8.58	8.78	8.30	8.94	8.58	8.90
Leominster, Mass.	22,000	99	136	7.38	6.30	8.60	8.68	10.40	9.14	7.00	10.12	10.30	9.53	5.90	6.67
Peabody, Mass.	22,000	85	..	7.50	7.05	7.57	5.62	8.12	11.23	11.62	10.85	8.40	7.55	7.03	7.60
Belmont, Mass.	21,748	100	59	7.71	7.54	7.62	7.93	9.08	10.67	10.35	9.21	7.77	7.44	7.50	7.16
Westfield, Mass.	19,775	7	95	7.37	7.11	7.56	7.58	8.00	9.27	11.13	9.95	8.46	8.01	7.51	7.98
Milford, Mass.	17,946	97	47	8.15	6.97	7.87	7.70	8.83	9.15	9.78	9.55	8.81	8.15	7.40	7.56
Milton, Mass.	17,507	100	47	7.48	6.71	7.42	7.20	8.87	9.00	8.77	8.48	8.92	9.62	9.81	7.74
Augusta, Me.	17,000	16	112	8.50	7.67	8.39	8.72	9.82	8.02	8.78	8.30	8.18	7.86	7.64	8.04
Wakefield, Mass.	16,318	97	42	8.28	7.66	8.32	7.88	8.42	8.92	8.87	8.71	7.96	8.35	7.70	8.80
Marlboro, Mass.	15,600	85	48	9.04	8.45	9.85	9.04	8.08	7.92	8.10	8.70	7.81	7.34	7.37	7.78
Danvers, Mass.	14,000	57	85	7.05	6.57	7.82	6.83	8.80	10.19	10.09	10.88	8.23	7.40	7.69	8.55
Webster, Mass.	13,000	94	48	9.58	7.46	8.53	7.93	7.89	7.93	8.27	8.30	8.07	9.08	8.34	8.40
Athol, Mass.	10,622	96	63	7.30	6.71	7.79	8.17	8.66	7.77	7.10	8.24	8.09	8.38	9.47	12.15
Reading, Mass.	10,500	96	..	7.54	7.44	8.20	7.75	8.86	9.66	9.50	9.73	7.85	8.08	7.54	8.48
Swampscott, Mass.	10,346	100	..	6.88	6.50	7.22	8.52	7.77	9.91	11.16	11.26	8.08	7.05	9.17	6.58
Rumford, Me.	8,726	100	100	8.03	7.21	7.85	7.30	9.77	8.00	7.90	8.07	8.51	9.84	8.61	8.85
Putnam, Conn.	8,000	5	116	7.50	6.70	7.84	8.20	9.60	9.63	9.40	9.25	8.42	8.10	7.82	7.58
Maynard, Mass.	7,200	90	44	7.90	7.14	6.81	7.62	8.31	9.32	9.30	9.40	9.06	8.48	8.53	8.15
No. Andover, Mass.	6,961	99	62	7.44	7.49	7.45	7.66	8.58	9.48	9.13	10.00	8.82	8.35	7.48	8.18
Mansfield, Mass.	6,700	95	..	7.64	6.75	7.70	7.37	8.49	9.77	10.77	9.45	8.81	7.82	7.28	8.08
Cherry Valley, Mass.	6,000	50	16	7.88	7.10	8.16	8.58	8.65	8.93	8.75	9.76	8.45	8.70	7.98	7.15
Franklin, N. H.	6,000	95	43	7.60	6.89	7.50	8.40	11.36	9.57	8.50	8.46	8.44	8.27	7.46	7.55
Great Barrington, Mass.	6,000	..	..	8.42	7.68	9.06	8.11	8.46	8.42	8.44	8.62	8.30	8.26	7.86	8.25
Whitinsville, Mass.	6,000	5	106	7.00	7.54	7.26	9.72	8.95	8.74	9.40	8.03	9.22	7.20	7.35	9.60
Calais, Me.	5,575	27	60	9.58	9.58	8.41	8.54	8.23	8.48	7.86	7.95	7.70	7.07	7.83	8.71
Dudley, Mass.	4,265		..	7.23	6.08	7.38	7.33	8.67	9.52	11.00	9.57	8.51	8.56	8.15	8.09
Williamstown, Mass.	4,007	100	..	10.42	7.34	9.90	11.40	8.14	5.72	7.48	5.62	6.85	8.82	8.90	9.37
Wrentham, Mass.	3,584	100	..	6.33	5.57	6.46	7.16	9.12	10.26	10.99	10.11	9.03	9.01	8.29	7.68
Manchester, Mass.	....	100	23	6.16	5.60	6.22	5.52	8.98	11.20	13.00	14.24	9.42	7.75	6.32	5.52
Salisbury, Mass.	....	..	..	4.50	4.77	6.02	6.12	8.77	11.96	13.80	16.77	9.45	5.52	6.04	6.28
Averages	....	80	72.7	7.80	7.09	7.88	7.75	8.67	9.06	9.49	9.26	8.51	8.29	7.92	8.10

94.6% of Water Plant Output Sold Through Meters



Output, sales and percent sold; 14 years' record

WATERFORD, N. Y., in 1929 accounted for 94.6 percent of the water delivered to the distribution system—actually measured that amount through meters. In 1931 the percent accounted for fell to 87.5 but rose to 91.9 in 1933. For the past five years the average percentage accounted for was 90.8. We believe very few cities can show, for even one year, an "unaccounted for" percentage less than 10.

We have asked R. G. Yaxley, water works superintendent of Waterford, for an explanation of this remarkable record, for the benefit of the hundreds of superintendents who are (or should be) desirous of equaling it. We give the facts and figures herewith.

The supply is obtained from the Hudson river, a soft water but badly polluted with sewage and paper mill wastes. It is filtered and pumped into two steel standpipes against a total head of over 300 ft. and distributed through 13 miles of mains to 1007 services. The daily percapita consumption has increased from 46.5 gal in 1929 to 51.4 in 1933. Of the latter figure, 30.5 gal. was domestic consumption, 13.4 was industrial, 3.2 was for public buildings, parks, etc., and 4.3 was unaccounted for.

The filter is a rapid sand, constructed in 1914 and kept modern by revamping. Treatment includes prechlorination with ammonia, pH correction with sulphuric acid, alum, sedimentation, activated carbon when necessary, filtration, aeration, soda ash for final pH correction, and secondary chlorination.

The pumping plant includes 2 high-head pumps and 2 low-head, all motor-driven centrifugals, acting against a total pumping head of about 295 ft. and giving 55% efficiency wire to water—not so bad considering the small output (less than 900 gpm) and the fact that the water is handled three times against heads of 32 ft., 26 ft. and about 237 ft. respectively.

The 13 miles of mains are 4 in. to 12 in., with 245 valves and 120 hydrants. There are 1007 services, of which about 50 are to the curb only. (These unused services are unsuspected points of leakage in many cities.)

For keeping leakage at a minimum, the procedure is described by Mr. Waxley as follows:

"First of all, the system is small enough (about 1000 services) so that we can keep a finger on things most of the time. Secondly we do it. Plant capacity is such that from 5 to 6 hours' operation per day takes care of the load, and close watch of recording pressure gauge charts, in particular readings during early morning hours, is a regular practice and any unusual drop in pressure is investigated. It is well known that the more leaks or wastes there are in a water system the more uniform the load will be from hour to hour. A tight system should show but little consumption during the early hours of a Sunday morning unless one has an industrial load that is active at that time. We have a 12" chart, 150 lb. range recording gauge, and many a Sunday morning it will fail to register a readable pressure reduction from 12 midnight to 5 A. M. in spite of the fact that our storage (steel standpipes) furnishes only about 17,000 gals. per ft. drop.

"We read our meters every three months, and a part of the meter reader's duty is to use the aquaphone on the service at the time he reads. Meters are all basement set. If he suspects leakage, he notes the fact on the meter card and it is checked up as soon as the report reaches the office. Twice a year all valves and hydrants are checked by a device like a doctor's stethoscope called the "Transmit-O-Phone." This is much more sensitive than the Aquaphone and is also used on services when following up the meter reader's report.

"We are especially fortunate in the type of water we have, in that meters stay in good condition over rather long periods. Being filtered, there are no turbidities to contend with, as it is soft; scale is unknown, and a soft slime forms inside the chamber of a disk meter until it is tight. House meters have been tested after several years of service and found correct within 1% at the extremely low rate of flow of one cu. ft. in 20 minutes. (A. W. W. A. standard is 1 cu. ft. in 7½ minutes.) We remove all house meters once in ten years for test, and find that satisfactory."

In 1920, only 38% of the output was registered on consumers' meters, although 96% of the services were metered. But many leaky services and an open blow-off were found, and in 1921, 45% was accounted for. From then on, leaks of all kinds were traced and remedied, the services 100% metered, and by 1926, 65% of the plant output was sold, and by 1929, 94.6%.

The domestic rate at present is 25 cts. per M gal., with a minimum rate for heavy industrial use of 10 cts. There is no minimum or service charge. These rates brought in total receipts in 1933 of $19,891; operating expenses were $13,575, repairs and extensions $3,418, and $2,028 was applied on the bonded debt. An additional $6,500 was paid on the interest and bond account from the town taxes, but no payment is made directly to the water department for use of the 120 fire hydrants or for water used for street and sewer flushing or in the public playground. The averages for the past five years are: Receipts $20,672; operating expenses $13,672; repairs and extensions $4,826; cash applied on bonded debt $1,678; paid from taxes $8,000. Meantime the total debt, bonded and current, has been reduced from $99,194 in 1929 to $79,000 in 1933. In 1920 the operating expenses were over $25,000, or 85% more than in 1933, although the amount of water sold was only about 80% as great as in the latter year.

Signs at a State highway intersection

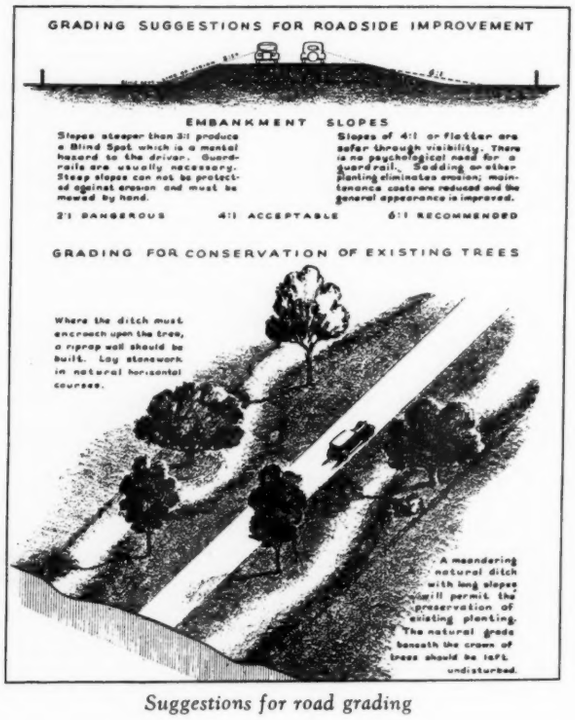
"Preserve This Tree" cards

Roadside Improvement in Texas

By Jac L. Gubbels
Landscape Architect, Texas State Highway Department

THE Texas State highways offer a great opportunity for roadside improvement. In the newly constructed highways of this state it is not difficult to obtain wide rights-of-way up to one hundred and twenty feet thus permitting us to make the roadsides fundamentally correct. Deep narrow ditches are avoided, and wide shoulders and long slopes are now the general practice. Soil erosion is prevented by the proper use of planting.

Gibb Gilchrist, State Highway Engineer, has made it possible to produce a roadside improvement plan on a large scale. Roadside improvement is most successfully carried out through the Maintenance Department under supervision of the maintenance engineer. A definite plan has been worked out for all roads to be executed by the maintenance forces. Each employee of the Maintenance Department has been instructed along this line and has been made conscious of the need for landscape work and general neatness and cleanliness along the right-of-way.


GRADING SUGGESTIONS FOR ROADSIDE IMPROVEMENT
EMBANKMENT SLOPES
Slopes steeper than 3:1 produce a Blind Spot which is a mental hazard to the driver. Guard-rails are usually necessary. Steep slopes can not be protected against erosion and must be mowed by hand.
Slopes of 4:1 or flatter are safer through visibility. There is no psychological need for a guard-rail. Sodding or other planting eliminates erosion; maintenance costs are reduced and the general appearance is improved.
2:1 DANGEROUS
4:1 ACCEPTABLE
6:1 RECOMMENDED
GRADING FOR CONSERVATION OF EXISTING TREES
Where the ditch must encroach upon the tree, a riprap wall should be built. Lay stonework in natural horizontal courses.
A meandering natural ditch with long slopes will permit the preservation of existing planting. The natural grade beneath the crown of trees should be left undisturbed.

Suggestions for road grading

The Texas State highway roadside improvement plan is strictly a utilitarian one. Approaches to cities, towns and villages are to be planted with trees and flowering shrubs to eliminate the unsightly views of utility lines and sign boards. Next, the alignment of the highways will be brought out more distinctly by proper plant grouping. For example, the outside of curves will be bordered with strong planting to show up the alignment by day or night. Steep vertical curves and hilltops are being planted in natural grouping to make it possible for the traveler to view the tops of trees on the other side of the hill and thus indicate the directions. At points where there is a combination of vertical and horizontal curves, this alignment planting is especially valuable, and is much more effective than signs.

A heavy planting group is placed on the opposite side of all junctions of either private, county or state roads. This treatment will make the traveler from lateral roads aware of the intersecting highways. All cross roads will be outlined with small white posts at intervals of fifty feet and at a distance of four hundred feet from the intersection, planting groups will be placed. This will give drivers definite warnings of cross roads.

By studying the guard rail problem in this state, it was discovered that in many cases rails are ineffective as a protection. At present speeds, the rails serve to minimize the mental hazard and not as a safety device. Proper heavy planting will give the desired psychological effect and will bring the vehicle to a full stop as well. Cherokee rose, sumac, hawthorn and other dense shrubs are used for this purpose.

The bridges and underpasses in our highway system are badly in need of a strong frame of greenery to do justice to the engineering design and harmonize the structures with the surroundings. Culverts will also be treated with groups of planting to conceal thus the mental hazard of a deep ditch.

On straight, level stretches of highways our plan calls for the planting of groups at intervals of three quarters of a mile to break the monotony of long roads and to make the driver more alert. All warning highway signs shall be given a background of evergreen planting to accent them and make them more readable. The prevention of erosion in ditches and on steep cuts is an important part of this work. Such plants as Georgia cane, honeysuckle, Cherokee rose, tamarox, etc., are used for this purpose very effectively.

All of these features have been undertaken in various parts of the state and have proven practical. Maintenance costs are being reduced as these plantings become established. It is expected these reductions will in time exceed the total cost of all roadside plantings.

This utilitarian plan of roadside improvement makes the highways incidentally attractive with a harmonious natural appearance. The maintenance forces of the Highway Department are now trained to collect all plant materials, and these men likewise plant and maintain them. It is the intention of the Highway Department that no plant material for state work shall be bought until all field forces understand how to take care of trees and shrubs. In the last season, 600,000 trees and vines were collected, planted and are now maintained by the regular forces. An unusual drought of ten weeks has been experienced in this state, and due to this there has been some loss.

Gibb Gilchrist, State Highway Engineer, appointed Mrs. Frank W. Sorell, of San Antonio, to head all civic organizations in the state to assist in roadside improvement work, such as the promotion of better entrances to farm homes, improvement of municipal grounds and schools, the painting of unsightly buildings, and prevention of dumping grounds near cities adjacent to highways.

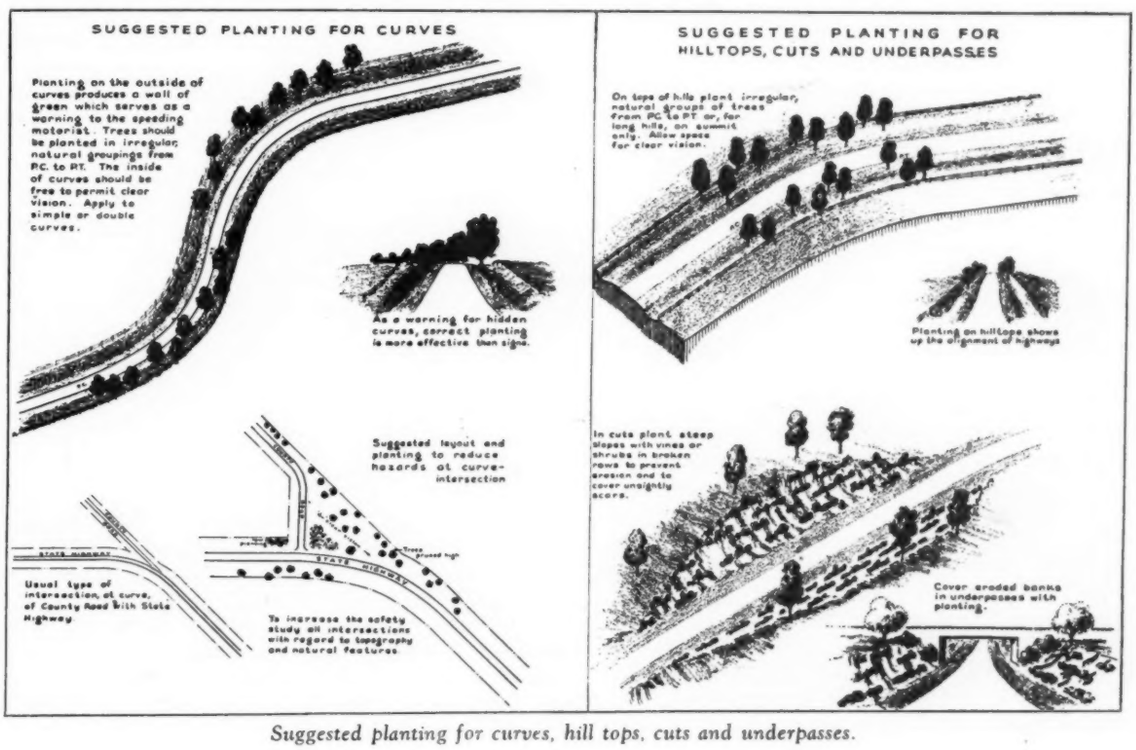
Service station operators along the highways are solicited to improve their grounds with a general clean-up and with proper planting. Wayside parks of from one to three acres are being established in all parts of the state. Here the traveler may turn off the highway for lunch or rest. Wyes at intersections are being formally treated to create interesting spots along the road. Wild flower seeds are gathered and sown in great quantities by the maintenance crews, and are distributed at points to prevent erosion.

Construction

In locating new highways, surveys of existing trees are being made in order that attractive groves will be preserved in construction. All desirable trees are marked to be saved and the contractor is held responsible for the protection of these trees. Where cuts are necessary, longer slopes are designed to be covered ultimately with vines and other plant materials to prevent erosion. In old rights-of-way, young sprouts which grow from old roots are being preserved, pruned, and cultivated. This method gives us an additional 300,000 trees throughout the state. Fences along railroads and farm land which are useless and are not maintained are being removed. Utility companies are cooperating by installing their lines where least damage is done to roadside trees. Trees are pruned by experienced tree trimmers under highway supervision.

Above: Trees at tangent intersection give advance information of curve. Below: Spanish daggers grouped at sign posts and along edge of embankment. Nueces Bay in the background.

The Highway Commission of this state are in full accord with the extensive roadside improvement plan. Under the National Recovery Act nine projects were let by contract to cover one-half of one per cent of the total allotment of highway funds for 1933-34. These projects are now complete and accepted with a guarantee that all planting which fails to grow will be replanted by the contractor at the next planting season.


SUGGESTED PLANTING FOR CURVES
Planting on the outside of curves produces a wall of green which serves as a warning to the speeding motorist. Trees should be planted in irregular, natural groupings from PC. to PT. The inside of curves should be free to permit clear vision. Apply to simple or double curves.
As a warning for hidden curves, correct planting is more effective than signs.
Suggested layout and planting to reduce hazards at curve-intersection
STATE HIGHWAY
Usual type of intersection, at curve, of County Road with State Highway
To increase the safety study all intersections with regard to topography and natural features.
SUGGESTED PLANTING FOR HILLTOPS, CUTS AND UNDERPASSES
On tops of hills plant irregular, natural groups of trees from PC to PT or, for long hills, on summit only. Allow space for clear vision.
Planting on hilltops shows up the alignment of highways
In cuts plant steep slopes with vines or shrubs in broken rows to prevent erosion and to cover unsightly scars.
Cover eroded banks in underpasses with planting.

Suggested planting for curves, hill tops, cuts and underpasses.

Two Years' Experience With the Phoenix Activated Sludge Plant

By Percy E. Mauzey
Operator, Phoenix Sewage Treatment Plant

General view of aerators, digestors (at extreme left), secondary clarifier and secondary pump house

IN March, 1932, Phoenix, Arizona, put into operation a sewage treatment plant comprising an automatically cleaned bar screen, primary clarifier equipped with sludge removal mechanism, five aeration and one reaeration tanks supplied with compressed air and agitated with paddles, secondary clarifier equipped with sludge removal mechanism, chlorine contact channel, a thickener, two digesters equipped with heating coils and provision for gas collection, a gas holder and water heater and six sludge drying beds with mechanical sludge conveyor. Dorr mechanism is used in the primary and secondary clarifiers, the aerators, digesters and thickener. Sewage is brought to the plant by a 54″ reinforced concrete pipe which is lined with vitrified clay blocks above the minimum flow line. The plant was designed by Clyde C. Kennedy, and construction was supervised by D. Travaini, who was retained as superintendent of the plant.

During two years of operation of this plant a number of interesting experiences have occurred and changes in operating procedure been made, some of which are described briefly herewith, as offering suggestions to operators of other plants.

The south *digester* was put into service March 17, 1932, and the north one on May 2. During the latter part of May both began to foam violently and sludge was drawn to prevent scum overflowing the manholes and clogging the gas collector lines. The sprays in the gas collector domes were too small to beat down the scum which filled the lines and the meter, and it was necessary to dismantle the lines, clean and reassemble them. To meet this objection, a ¾″ water line was connected to the gas lines at each collector dome, through which water under pressure could be used to flush them, and 1½″ pipes were connected to the gas lines in the power house to remove the sediment and water from them without having to dismantle them. Foaming continued until the latter part of January, 1933, but there has been no trouble since then. Whenever foaming became excessive, temporary relief was obtained by raising the pH above 8.5 by use of hydrated lime.

The *thickener* was used to concentrate a mixture of primary sludge, excess activated sludge and digester overflow, but owing to the septic condition of the last and the high atmospheric temperatures—well over 100° in the shade—odors were produced and septic floc flowed to the primary clarifier. The digester overflow was diverted to the sludge drying beds, but even then sludge could not be retained in the thickness long enough to give the desired concentration unless some provision be made to retard septic action. Early in October plant effluent was turned into the thickener with the hope that its dissolved oxygen would retard septic action, but this caused excessive short-circuiting in the thickener. Then lime was tried, which caused the sludge to settle rapidly and, keeping the pH above 8.5, inhibited bacterial action. This permitted thickening of activated and primary sludge both separately and combined, without odors or scum and with a 2 to 3% increase of ash content of the thickened sludge. In May, 1933, a Sacramento type baffle was installed to diminish short-circuiting, and a W & T solution feed chlorinator to permit using liquid chlorine to retard septic action. Since August, 1933, standard practice has been concentration of mixed liquor only, which has been performed satisfactorily.

Aeration operated satisfactorily until September, 1932, when the activated sludge bulked very badly. This was undoubtedly due to tomato seeds and peach scrap, with which the sewage was heavily loaded. Several applications of lime to the sludge in the aerators and reaerator solved this problem. To facilitate this, a large wooden tank was rigged up with water connections and an air agitator on the bottom, to permit constant dosage of milk of lime at the aerator influent.

With the passing of the canning season, the sludge gave no further trouble until December, 1932, when a strong phenolic odor was noticeable and increased in intensity. Lime applied to both raw sewage and aerators was ineffective. The phenols were found to be coming from a gas plant which manufactured gas from crude oil, the waste from which was clear and was used for irrigation during the summer months by the park department, but during the winter was not used and was turned into the sewer. When spring arrived and irrigation began again this trouble ceased. An ordinance forbade dumping of gas plant waste into the sewer, but as this plant was to be replaced with natural gas in a few months, it was not enforced.

The sludge is mechanically agitated by two lines of paddles extending the full length of the aerators and reaerator, which rotate against the air stream. The load on the driving mechanism caused excessive breakage of links and pins, and was reduced 20% by advancing the angle of the paddles at the outer side 13° without sacrificing the efficiency of the stirring. Also heavier chains were substituted for the original drive chains and an additional shaft support pier was added near the sprocket, but link and pin breakage has continued and the problem is still being studied by mechanical experts.

Rotary-type blowers supply air for aeration through porous plates in the center of the tank. Whenever blowing is stopped to permit partial emptying of the tank for repairing the chains, the plates are clogged by setting sludge. Cleaning the filtros plates has been effected more or less satisfactorily by brushing with a wire broom and burning with an acetylene torch. The present practice is to flush the plates with a stream of water as soon as possible after emptying the tank, meantime maintaining a low air pressure, and permitting them to dry. If they are sealed with sludge, we use a portable electric grinder fitted with a round wire brush replacing the stone on the grinder shaft, to brush the plates until the gray or brown appearance is removed; which method is effective for surface clogging.

Thickener, showing stirring mechanism and Sacramento baffle

Sludge pumping is performed by three plunger-type pumps, which draw sludge from the clarifier through 185 ft. of 8 in. pipe containing several bends. The suction is very great and causes excessive wear in the packing. Even if a new packing which has recently been developed should remedy this trouble, it is hoped that the suction lift may be reduced by relocating the pumps near the clarifier and at the level of the hopper, so that the sludge will flow to the pumps by gravity.

No *grit chamber* was included in the plant and total and partial clogging of lines with sand has resulted. Use of a "crawler" or a fire hose has generally been effective in cleaning these, but early in 1933 grit and sand completely obstructed the primary sludge line. The tank was pumped empty, the flow being by-passed, and about 5 truck loads of grit were removed. Much grit also passed to the thickener, from which we have at various times removed a mixture of sludge and grit by stopping the thickener mechanism and allowing the grit to settle and pumping out the supernatant. More than 15 truck loads of grit were removed by bucket. Grit also passes to the digesters, clogging the drain lines to the drying beds. A grit chamber is to be added in the near future.

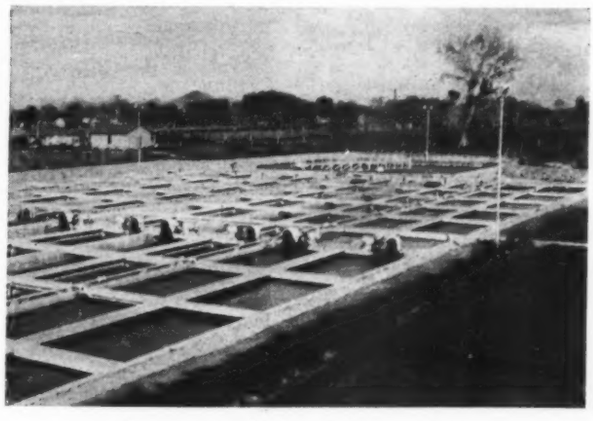
Return sludge settled in the channels, and efforts to prevent this by agitation by water from a hose were not entirely satisfactory. A better method has been adopted, placing in the channels lines of 2″ pipe with 1/32 in. holes drilled at 4 in. intervals, which distribute in the return sludge air taken from the main air lines.

Valve corrosion has necessitated replacement of a great many stems and gates. Using a non-rising stem valve permits corrosive action of sludge to get in its best work, as gate and stem are submerged in the sludge, whether the gate is open or closed, and the threads on stem and gate are corroded rapidly. Rising stem valves should retard this action; with the additional advantage that the operator can determine at a glance whether the valve is open or closed.

The screened material is sprayed with a strong solution of Germite and buried, and the burying pits are sprayed weekly with a solution of borax to prevent fly breeding. Germite is used for daily spraying the pump room and screen house, and all buildings are sprayed with fly-spray to kill any live flies. There has been little trouble from these or from mosquitoes, a mixture of kerosene and oil being applied weekly to probable mosquito-breeding places.

The grounds around the plant were leveled for irrigation and thoroughly plowed, and an irrigation system installed consisting of standpipe, concrete pipe and ditches by which plant effluent is distributed. A heavy layer of sludge has been applied to the land. Ornamental trees, shade trees, palms and tamarisk trees have been planted and are growing rapidly. Roses, oleanders and ornamental hedges border the lawns about the buildings and add to the attractiveness of the grounds. A rubble wall on a 1:¾ slope surrounds the primary clarifier, the aeration field and the secondary clarifier. All the walks and driveways about the plant have been graveled. Gigantic flood lights illuminate the grounds at night.

The above is abstracted from a paper read at the annual meeting of the Arizona Sewage Works Association.



Aerators, preclarifier and screen house

Fourth of a series of articles on the utilization of soil analysis in economic highway construction.

Compressibility and Elasticity of Soils Indicated by Flocculation Constants

By the Division of Tests, U. S. Bureau of Public Roads
Reported by C. A. Hogentogler, Senior Highway Engineer

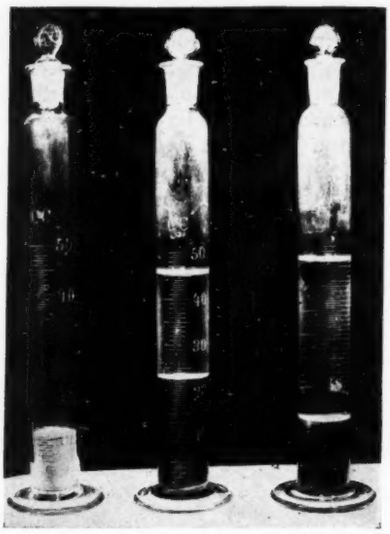


FIG. 6—*Graduated cylinders and soil samples used in the flocculation test. Left, powdered soil; middle, flocculated sediment; and right, deflocculated sediment*

COMPRESSIBILITY is the property which causes soils to deform vertically under load in proportion to the decrease in the air or the moisture content. A compressible soil does not displace laterally or bulge adjacent to the loaded area as in loss of stability. The deformations are more or less permanent in character and remain after removal of the load. (See figure 1, middle.)

Granular particles which furnish internal friction, clays which supply cohesion (See PUBLIC WORKS, August, 1934) and silts which function principally as inert filler in soil road surfaces are the materials which cause soils to be compressible. The density together with the corresponding stability of soils composed of these materials may be greatly increased by means of heavy rollers or similar equipment used to compact fills, subgrades, and soil road surfaces during construction.

Elastic Soils Difficult to Compact

Elasticity, like the lateral flow previously described, causes soil to displace laterally under load and bulge adjacent to the loaded area. (See figure 1, bottom.) However, elastic deformations have the character of jelly-like distortions which remain only while the soil is loaded, as distinguished from the permanent shearing of the soil along definite planes due to lateral flow (see PUBLIC WORKS, August, 1934).

Mica flakes, diatoms, and peat, without appreciable cohesion and internal friction but with the shape and character of particle productive of high air content or water capacity, are among the soil materials which furnish elasticity.

Soils with this property rebound upon the removal of load and therefore cannot be permanently compacted by rolling or other temporary application of load. Attempts to effect such consolidation may even result in serious damage to both concrete pavements and macadams, for subgrades of the elastic type may rebound after the thorough rolling which benefits compressible materials and cause concrete pavements to crack during the setting period, or may distort sufficiently under the travel of heavy material trucks and mixing apparatus to injure pavements newly constructed nearby. Elastic subgrades are responsible for the "alligator hide" cracking through which water may enter the subgrade and cause the ultimate failure of macadams.

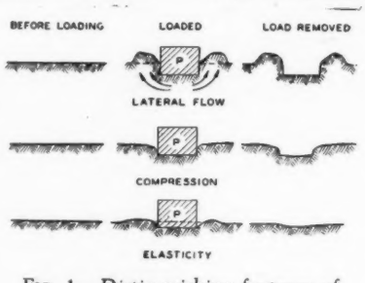


FIG. 1—*Distinguishing features of soil settlements due to load*

The photomicrographs, figures 2 and 3, show the highly irregular shape of the particles of elastic materials as compared with the bulky or granular appearance of the compressible sand and silt particles. Even in colloidal form, clays of the two main groups, those from kaolinite, which provide the good soil binders, and those from the bentonites, noted for high cohesion and volume change, have relatively dense structure. The highly unstable mucks from river and lake bottoms contain both cohesive and elastic materials. (See figure 2-F.)

Volume of Solids Fairly Constant

Regardless of character, the solids have presumably constant volume and only the pores enlarge and shrink as soil changes in density. (See figure 4-A.) Thus, change in clay from the dry to the wet and muddy state during rain is not due to change either in size or character of solids but, instead, to the enlargement of the pores caused by the entrance of water.

Drop in density due to this enlargement of pores accounts for the very low stability, say, 400 pounds per square foot, of the wet and muddy soil as compared with more than 10,000 pounds per square foot for clays in a fairly dry or damp state. (See PUBLIC WORKS, August, 1934.)

Voids Ratio and Moisture Content Defined

The density is indicated by values of the "voids ratio" and the "moisture content." The voids ratio, or pore-solids ratio, designated by the letter "e" (fig. 4-B) is the ratio of the voids or pores to the solids, by volume. The moisture content, designated by the letter "w" is the percentage of moisture to solids, by weight.

In completely saturated soils, when G = the specific gravity,

$$e = \frac{w}{100} G \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

This is because

$$e = \frac{\text{cc. of water}}{\text{cc. of solids}} \text{ and } w = \frac{\text{gms. of water}}{\text{gms. of solids}} \times 100$$

One cc. of water weighs 1 gm. and 1 cc. of solids weighs Ggms. Therefore

$$w = \frac{\text{cc of water}}{G \times \text{cc. of solids}} \times 100$$

When G = 2.71 as in the case of the muck soil, sample no. 8170, and others used for illustrative purposes in the following discussion,

$$e = \frac{2.71\ w}{100} = .0271\ w.$$

Performance of Soils Indicated by Density

The range in the consistency of soils is disclosed by the performance of earth layers, beginning when the soil particles first settle out of suspension, continuing while the sediments thus formed are drying or being otherwise consolidated to constant weight, and concluding with the rewetting of the dried soil.

During consolidation, drying and rewetting, granular materials change but little in density. The micaceous and the diatomaceous soils and the colloidal clays change enormously not only in density but also in the corresponding stability and compressibility.

The total range in density, combined with the density at particularly selected degrees of consolidation, shrinkage, and swell, indicate the extent to which soils have the properties which control deformation. Consequently such densities are the basis of soil identification by means of physical tests.

Maximum Porosities of Soils Differ Widely

The characterizing performance is first noticed when the soil materials are settling out of suspensions and forming sediments. Granular particles settle independently with the larger grains falling the faster. The sediments thus formed are stratified, with the larger soil particles in the bottom layer, and dense, as shown in figure 5-A. The sediments of the cohesionless micas, diatoms, and the like, are also stratified but highly porous.

When highly cohesive clays settle out of suspension, flocculated masses of colloids trap the larger soil particles and all settle together. As a result, the clay particles are distributed throughout the sediments which are highly porous and without stratification, as shown in figure 5-B.

Deflocculents which destroy the electrolytic bonds of colloidal flocs release the clay particles to settle individually like bulky grains and form stratified sediments as shown in figure 5-C.

Flocculation is a common natural phenomenon, being produced generally by the limes and the magnesias as well as by obscure electrical phenomena. The sodas and potassiums, and also certain physical agencies such as heat and agitation, serve to deflocculate or disperse colloids. Flocculation accounts for the better drainage of farm lands after being limed. Milk is curdled by flocculation upon the addition of lime-carrying fruit and vegetable juices. The value of sodium in the bicarbonate form for preventing such curdling is well known to every housewife.

Essential Features of the Flocculation Test

Essentially, the flocculation test* consists of determining the porosity of soil samples in the dried and powdered state as prepared for the routine soil tests (*Public Roads,* October, 1931) and at maximum water capacity in both the flocculated and the deflocculated states.

Five cc. of soil solids are placed in a graduated cylinder of 50 cc. capacity having a glass stopper (see fig. 6). The cylinder is then jarred slightly, after which the volume of the soil is observed. Forty cc. of distilled water are then added to the soil, after which the cylinder is shaken vigorously.

Another 5 cc. of the air dried soil, with 39 cc. of distilled water and 1 cc. of sodium silicate deflocculent (see *Public Roads,* October, 1931) are placed in a second cylinder and thoroughly mixed. The volume of

*Public Roads, Oct. 1931. Item 4 under "Mechanical Analysis." Proc. Twelfth Annual Meeting of the Highway Research Board, pp. 162-166, inclusive.

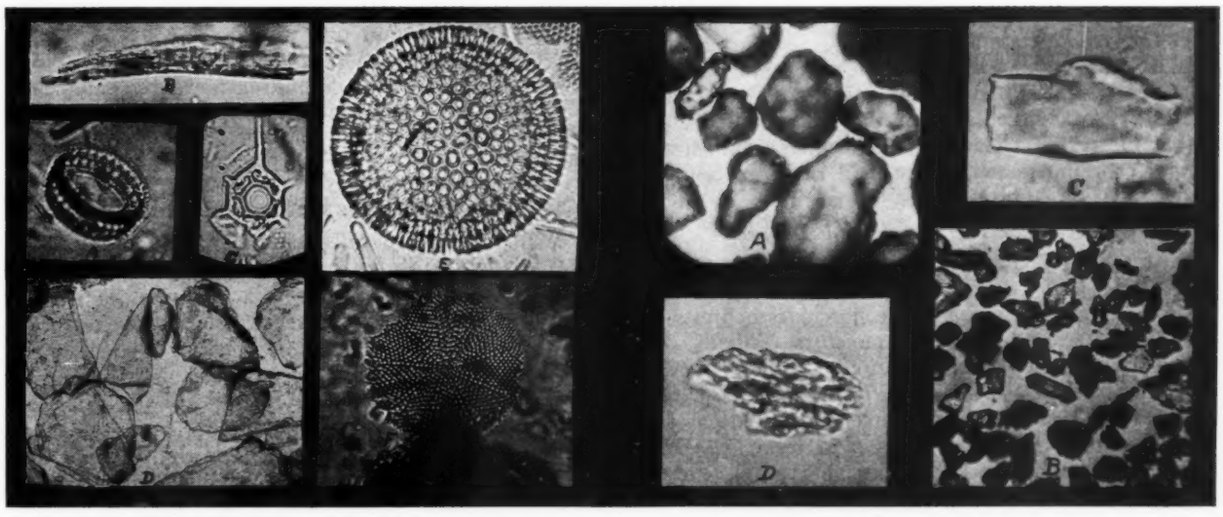


FIG. 2—*Materials Productive of Elasticity in Soils*
A—Diatom. B—Fibrous peat. C—Diatom. D—Mica flakes. E—Diatom. F—Diatom and amorphous organic matter in muck sample.

FIG. 3—*Constituents of Compressible Soils*
A—Sand (2.0 to 0.84 mm). B—Silt (0.05 to 0.03 mm). C—Kaolin particle. D—Bentonite particle.

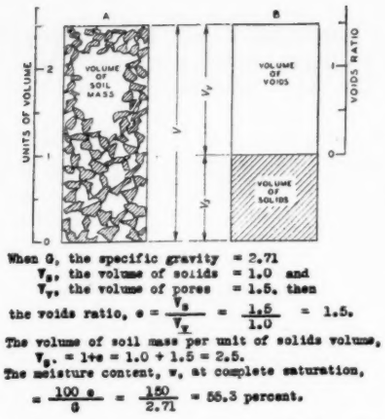

A
B
UNITS OF VOLUME
VOLUME OF SOIL MASS
VOLUME OF VOIDS
VOLUME OF SOLIDS
VOIDS RATIO
When G, the specific gravity = 2.71
V_s, the volume of solids = 1.0 and
V_v, the volume of pores = 1.5, then
the voids ratio, $e = \frac{V_v}{V_s} = \frac{1.5}{1.0} = 1.5$.
The volume of soil mass per unit of solids volume,
$V_s = 1+e = 1.0 + 1.5 = 2.5$.
The moisture content, w, at complete saturation,
$= \frac{100\ e}{G} = \frac{150}{2.71} = 55.3$ percent.

FIG. 4—*Illustrating pores, solids, and moisture content*

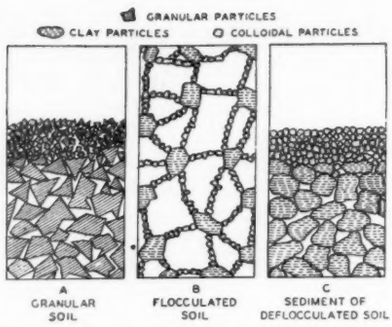


FIG. 5—*Illustrating the effect of granular particles, flocculation, and deflocculation on the character of sediments*

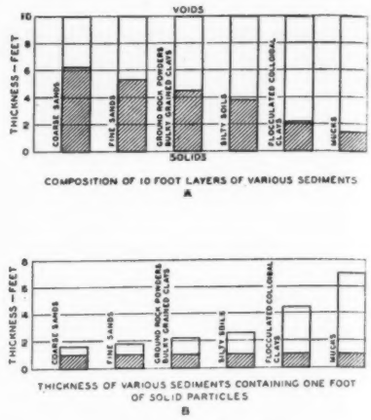


FIG. 7—*Relative porosity of sediments of common soil materials*

the sediment in each cylinder is observed at the end of 24 hours.

The volume of the soil mass minus 5 cc. equals the volume of the pores in cc. This divided by 5 cc. equals the voids or pore-solids ratio.

High Porosities Due to Elasticity, Capillarity or Cohesion

A pore-solids ratio of 0.90 represents the loosest possible arrangement of bulky spherical particles of equal size. The more the pore-solids ratios of the dry samples exceed 0.90 the more is indicated the presence of the irregularly shaped micaceous, diatomaceous or fibrous peat particles productive of high elasticity.

The more these ratios of the deflocculated sediments exceed those of the powdered samples the greater is the indicated capillarity of the soil exclusive of that due to flocculation. The more the pore-solids ratios of the flocculated exceed those of the deflocculated samples, the more is indicated the presence of the colloids which furnish cohesion as well as capillarity.

The sediment in the middle, figure 6, is flocculated and the one on the right, deflocculated. The former is homogeneous, with a pore-solids ratio of 3.5. The latter is stratified and has a pore-solids ratio of 1.6. The pore-solids ratio of the powdered soil on the left is 1.0. Thus the effect of capillarity exclusive of that due to colloidal flocs was to raise the pore-solids ratio from 1.0 to 1.6. The flocculating colloids alone were able to effect a further increase from 1.6 to 3.5, which indicates fairly high cohesion.

In contrast to this a sample of the cohesionless, highly elastic mica flakes had a pore-solids ratio of about 6 in the dry, the flocculated or the deflocculated state. Stable fine granular material, on the other extreme, with neither cohesion nor elasticity, had ratios of approximately 0.90 in all three states.

Flocculation Factor and Limit Defined

Flocculation factors are defined as the pore-solid or void ratios of the deflocculated sediments obtained in the manner just described. The flocculation limits are defined as the corresponding moisture contents. The limits are furnished by substitution of numerical values for voids ratio and specific gravity in formula 4. Generally, the flocculation factors of typical soil materials are as follows: Coarse sands, 0.6 or less; fine sands, 0.6 to 0.8; ground rock powders, 0.8 to 1.2; average silty soils, 0.8 to 1.6; colloidal clays, 1.6 to 3.5; mucks, peats and highly micaceous soils, 5 to 8.

The effect of these factors upon the composition and the thickness of deposits is illustrated in figure 7, which is of special interest in connection with the construction of hydraulic fills. Figure 7-A indicates the lower densities which cause the muck and clay deposits to be so much softer than fills of silt and sand.

A deposit of muck 7 feet thick has exactly the same amount of solids as a deposit of silt 2.5 feet thick and a layer of sand 1.5 feet thick. Therefore, if the price of muck per cubic yard were but five cents, the corresponding price of silt and sand required to furnish the same amount of solids would be respectively 14 cents and 23 cents.

The flocculation test was devised principally for determining the extent to which soil samples contain flocculating agents. However, the possibility of using the test to disclose information on additional soil properties at the same time was soon recognized. This included the elastic, the capillary, and the cohesive properties as noted above and the grading as indicated by the strata of the deflocculated sediments.

An extremely simple form of the test is suggested by Joel D. Justin† for use in connection with the selection of soils for use in earth dam constrution.

A small amount of the dried material is powdered between the fingers, dropped into a test tube and settled by tapping. A sticker is placed on the glass tube to mark the top of the powdered soil deposit. Water is then added and thoroughly mixed with the soil by shaking the test tube with the thumb held over its mouth. The mixture is then allowed to rest for 24 hours.

Volumes of the resulting wet sediments which exceed the volumes of the corresponding powdered samples by more than 50 percent indicate soils which are not suitable for use in dams constructed by the hydraulic method.

Some Performance Records of Paving Mixers

It has been generally estimated that most concrete paving mixers do not have an economic life exceeding about 35 miles of concrete road. Replies to a recent questionnaire, sent to 10 representative contractors by the Chain Belt Co., indicated mileages of concrete road laid to be as high as 75. The contractor reporting this mileage stated that his highest mileage per season was 25 miles of road. Another reported 28 miles per season. The average of the 100 replies for total use was 37.62 miles, with at least two of the machines evidently in use but little more than one year. The average of the highest mileage per season, for the ten, was 22.975.

†Justin, Joel D. 1932. Earth Dam Projects, John Wiley & Sons, page 102.

Water-Supply Conditions in the Drought-Stricken Regions*

By O. E. Meinzer
Geologist in Charge, Division of Ground Water, U. S. Geological Survey

I HAVE been asked to give information on the water-supply conditions in the drought-stricken region of the north-central part of the country, the prospects of replenishment, and the practicable measures that can be taken to relieve the situation and to produce permanent improvement.

I have been in the drought-stricken region most of July and August, and have conferred with the State geologists and others who are rendering effective service in the towns and rural districts where water shortage has developed. This region is so large and has so many variations in rainfall and in geologic and ground-water conditions that it is difficult to make a brief statement that is correct for all parts of the region. The following remarks refer to conditions as I observed them in July and August.

Existing Conditions

In the aggregate, many water supplies have failed or become inadequate, and in some parts of the region the water situation has become critical. However, the situation is encouraging in that the recognized water-bearing formations are in general supplying the demands made upon them without serious depletion.

In most of the region the precipitation was below normal during the last few years, drought conditions prevailed extensively in 1933, and there was a general lack of precipation during the winter of 1933-34. Thus, the present water-supply depletion is only partly the result of the fierce drought of the present summer; in large part it is the result of an accumulating series of unfavorable conditions.

The municipalities that are experiencing water shortage are chiefly those which have surface reservoirs supplied by stream flow. Likewise, on the farms small reservoirs supplied by run-off and cisterns supplied by rains have largely failed except as they are here and there replenished by rain storms. Small lakes that depend largely on direct rainfall and storm run-off have also shrunken greatly or have dried up entirely. There has, moreover, been a considerable lowering of the ground-water table, chiefly because of the inadequate replenishment during the normal replenishing seasons of winter and spring in the last few years, especially the winter and spring of 1933-34. The lowering of the water table has resulted in the decline or drying up of the springs, which represent the overflow of the underground reservoirs, and hence it has resulted in the drying up of many of the streams, which, except in freshets, depend upon the overflow of the underground reservoirs. Moreover, it has caused the failure of many shallow wells that obtain their supplies only a short distance below the water table. The deeper wells that draw from the principal water-bearing formations have not been much affected by the drought and in general their supplies are secure.

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At a time like this there is an increased draft on many of the reliable wells to supply the water which would normally be obtained from surface sources or from shallow wells that are failing, and also to supply the increased consumption from city water-works for sprinkling lawns and other purposes. Thus, there is likely to be an overdraft on these perennial wells beyond their normal capacity or beyond the normal capacity of the pumping equipment. The resulting trouble may be widely heralded as evidence that even the most reliable sources are going dry, thus producing much needless alarm.

Most areas of the drought region are underlain by reliable water-bearing formations. The glacial drift, which covers most of the region, contains many beds of saturated sand and gravel and is the most valuable and widely utilized source of ground water. Among the underlying rock formations the most valuable for water supply are (1) the great series of sandstones and cavernous limestones of Paleozoic age (chiefly Cambrian, Ordovician, Silurian, Devonian, and Mississippian), which are extensively utilized especially in Wisconsin, Illinois, Minnesota, Iowa, and Missouri; (2) the Cretaceous sandstones, especially the Dakota sandstone, which yield reliable supplies to many thousands of artesian wells in North and South Dakota and adjacent areas; and (3) the extensive strata of sand and sandstone of Tertiary age (Eocene to Pliocene), and associated Pleistocene deposits of sand and gravel, that yield reliable supplies to wells in most of western North Dakota and the northwest corner and southern margin of South Dakota and in the western and some of the central and eastern parts of Nebraska and Kansas.

Even in the favorable areas much trouble has been caused by the failure of surface supplies and shallow wells, because considerable time is required to drill and develop deep wells, and some uncertainty as to local conditions is always involved. Moreover, the cost of deep wells is beyond the present means of many people.

In eastern and central Kansas, northern Missouri, southern Iowa, and the southeastern corner of Nebraska the ground-water conditions are unfavorable and the water-supply problems are accordingly widespread and critical. Similar critical conditions extend through Oklahoma and into northern Texas. Most of this area is underlain by Pennsylvanian or Permean rocks, which consist largely of shale with interbedded strata of sandstone that contain highly mineralized water. Where the shale is at the surface, the existing wells are very shallow and weak and fail readily in times of drought. In the northern part of this unfavorable area the bed rock is overlain by the older drift sheets which are here deficient in water-bearing material. In the western part of the area, Cretaceous rocks lie at the surface and overlie the Permean and Pennsylvanian rocks. The Creteceous shale is almost barren of water and the underlying Cretaceous sandstone, back from the outcrop,

is said to contain water too salty for use. This is in contrast to the conditions in much of western South Dakota, where the sandstone underlying the unproductive Cretaceous shale yields water which, although highly mineralized, can be used for stock and even human use. Serious trouble has also been reported in other parts of the region where the glacial drift is thin or deficient in water-bearing beds.

In the unfavorable area in Kansas, Missouri, and Iowa, the towns have largely built surface reservoirs and the farms are largely supplied by small reservoirs for stock and rain-water cisterns for human use, but there are also many shallow wells, most of which are weak and unreliable. Hence, some of the towns have been faced with water shortage and a few have been compelled to import water in tank cars. Hence, also, many of the farmers have been compelled to haul water, some of them from considerable distances.

In this unfavorable area the largest and most reliable supplies of ground water are obtained in deposits of alluvium in the valleys. In some localities valley deposits are almost the only present source of supply. The valley bottoms are generally covered with a growth of trees which in the drought periods draw heavily on the ground water, and in some places have lowered the ground-water table to levels fully 15 feet below the bottoms of the stream channels. An automatic water-stage recorder, maintained on an observation well in one of these valleys where there was a good stand of oak trees, showed a characteristic daily transpiration curve, with a drawdown of the water table amounting to nearly 3 feet in two months.

Prospects for Replenishment

Replenishment of the surface reservoirs will, of course, occur as soon as there is enough rainfall to produce run-off. It is important to recognize, however, that there may be further depletion of the ground-water supplies before the drought is so effectually broken that water from rain and melting snow will penetrate deep enough into the earth to be added to the storage in the underground reservoirs. In a normal summer the soil moisture is depleted by the demands of vegetation and direct evaporation. After the first killing frost, however, each rain contributes water to the soil zone until the deficiency in moisture is fully removed, after which some of the rain water penetrates to the water table. During the winter the process is interrupted when the ground is frozen and the snow accumulates. In this region the heaviest ground-water rechange is likely to occur early in the spring when the snow melts and the frost leaves the ground. Following the severe drought of 1930 and the dry winter of 1930-31, no recharge occurred in the locality of the United States Geological Survey observation well near Washington, D. C., until March 28, 1931. If there had been a little less precipitation we would have passed into the growing season of 1931 without any recharge in that locality. In view of the present severe depletion of soil moisture in much of the north-central region, it is quite possible that in parts of the region the growing season of 1935 will be reached without enough precipiptation to produce substantial recharge. In that event we may expect low ground-water levels next year and no good prospects of improvement before the spring of the following year.

Eventually there will doubtless be copious rains that will raise the ground-water levels and will cause the underground reservoirs once more to overflow freely. The drought has caused widespread fear that the ground-water levels will continue to decline from year to year with progressive depletion of the ground-water supplies. I can see no basis for this fear, except in certain localities of excessive pumpage for municipal, industrial, or irrigation use and in areas of artesian flow where much water is wasted through flowing wells.

Intensive studies have been made or are in progress to determine the quantities of water that are perennially available in many of the areas having large ground-water developments, in order that overdevelopment of any source may be prevented and orderly plans may be carried out for obtaining needed additional supplies from other available underground or surface sources. It does not appear that there is any danger of ultimate exhaustion of the ground-water supplies required for domestic and stock use in rural districts.

Remedial Measures

For many years systematic studies of ground-water conditions have been conducted throughout the United States by the United States Geological Survey in cooperation with the State geological surveys and other State organizations concerned with water resources. The results have been published in numerous reports, as for example, Water-Supply Paper 293, which contains a brief description of the water-bearing formations in every county in Iowa. It was for such a day as this that the systematic ground-water work was done.

In my judgment the water-supply situation is, on the whole, being handled very adequately by the Federal drought-relief agencies, cooperating with the State health departments and other permanent State and local organizations. The State geologists and their assistants are actively rendering service in directing the efforts of the relief agencies, and this service is effective because of the foundation that was laid in the previous systematic work.

Since the drought has become severe, many methods have been proposed for artificially increasing the ground-water recharge, such as spreading water of streams and building dams to impound the storm water. It is doubtful if these methods will be found to have much applicability in the north-central region. If extensive changes are made in crops and farming methods to prevent soil erosion, some changes in ground-water recharge will doubtless result, and under certain conditions there will be an increase in recharge. The Geological Survey is cooperating with the Federal Soil Erosion Service in establishing observation wells for periodic water-level measurements in some of the controlled areas in order to study the effects of erosion control on ground-water recharge.. The greatest progress toward more abundant and reliable water supplies will, however, probably be achieved through more adequate development and utilization of the natural supplies as they are provided by the more or less normal recharge of existing underground reservoirs.

Some Cost Data on Maintenance

Washington County, O., has used two F W D trucks equipped with a 10-foot blade for maintenance work. During the first year, these operated 20,000 miles each on the original pneumatic tires. Each truck maintained an average of 17 miles of road per day, averaging 51.7 miles per day. Blades averaged 1000 miles before replacement. Gasoline mileage was 2.2 miles per gallon. Cost of operation, including depreciation, gasoline, oil, tires, operator, blades, and all other items, was 70 cents per mile of maintained road, or $12 per day.

The Editor's Page

Underground Water for Public Supplies

Probably one hindrance to the more general use of underground water supplies in the considerable area of the United States where they are available is the lack of sufficient definite and assured information concerning them. The U. S. Geological Survey has made considerable progress in supplying this deficiency, and it is believed that there will in the future be increased advantage taken of the possibilities these supplies offer. In the districts now suffering from the drought these possibilities are especially important. Because of this, we have asked O. E. Meinzer, of the Geological Department, to tell of the conditions in those districts as he found them last month, which he does in the article on pages 19 and 20.

Concerning the possibility of avoiding a repetition of such conditions he says:

"My vision of the future water supplies of the people of the United States, including the north-central part, is not a gloomy one, but on the contrary, very optimistic. Roughly, half of the American people, residing chiefly in the smaller cities and towns or on the farms, obtain their water supplies from millions of wells which tap many different water-bearing formations with almost infinite variety in the quantity and quality of water that they yield. Much progress has been made in regard to the ground-water supplies but they have not been given the attention that they deserve, and because of the large number of unit installations and different sources of supply they constitute an exceedingly complex and difficult problem. Great possibilities of improvement still exist and a great challenge to further achievement. Much more work needs to be done to locate accurately all the water-bearing strata, to determine the quantities of water that they will perennially yield, to ascertain the mineral constituents of the water from every horizon, to construct wells that will draw from the desired horizons and will be productive, durable, and thoroughly sanitary; to treat the ground waters where treatment is needed and practicable in order to destroy bacteria and remove iron and hardening or other undesirable mineral constituents, and to install pumping equipment, distribution systems, and plumbing facilities that will make the water conveniently and abundantly available.

"The present drought, disastrous though it is, is producing the beneficial result of promoting this program of better water supplies for the smaller towns and rural districts. The ground-water supplies that are being discovered and developed in the present emergency work will be perennial supplies of permanent value. Where adequate ground-water supplies can not be found, the surface reservoirs for municipal and farm supplies will be enlarged and improved against the next drought emergency. It should not be assumed that all the undeveloped water in the deeper strata of Pennsylvanian, Permean, and Cretaceous rocks is unfit for use. A program of test drilling by skillful water-well drillers, under rigorous technical supervision, to determine the yield and quality of water in each individual stratum would doubtless show important differences in quality that are not now known and would probably reveal supplies that would at least be valuable as reserve supplies in times of drought.

The drought has also given impetus to the program of periodic measurements of the water levels in widely distributed observation wells, which should enable us at any time in the future to know the exact stage of the water table."

Cities Show Improvement in Finances

A survey of the financial condition of leading cities of the United States, which was published in the daily papers during the early days of August, indicates that in all sections of the country the outlook from the finance viewpoint is the brightest for several years. Strict economy and recent greatly increased tax collections have combined with better bond issue conditions to place these cities in a very advantageous condition. Back salaries have been paid up, salary cuts have been restored, and operating deficits have almost disappeared.

This magazine has predicted that, after the storm of the depression has passed, cities, and counties also, would be in the best financial condition in years. Despite the work done and under construction through the stimulus of the PWA and by other government agencies, a tremendous amount still remains to be done in paving, sewerage and sewage treatment, water supply and water purification, and refuse disposal, as well as in the numerous allied lines of public works, and with returning prosperity in city and county finances there should be no diminishing of operations in the public works construction field.

Drainage and Conservation

A southern state reports more than 80 miles of drainage ditches dug for mosquito control through cooperation with the Relief Administration. Many other states have made similar reports. Much good has been accomplished by this work, for malaria is a major health problem in a large portion of the United States.

But drainage work should be viewed in its larger aspects. Swamp areas afford places where wild life—ducks, squirrels, rabbits and many other varieties of game—can exist in comparative safety and can multiply. Swamp areas also hold back flood waters and retard runoff, and in this way they are probably an important factor in water conservation. For rapid runoff, through artificial ditches, reduces the amount of water that soaks into the soil and is added to the ground water, which is rapidly becoming one of our most important sources of municipal and industrial water supply.

Engineers are peculiarly fitted to view this problem in its broadest aspects and to plan drainage works—when they are necessary—so that the greatest good is accomplished, with the least damage to ground waters and to wild life.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

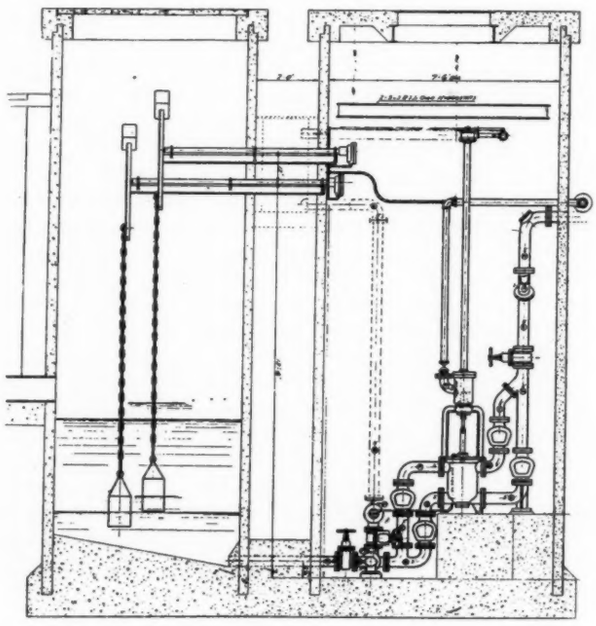
PUMPING sewage from three low zones of the parish of Cricklade, England, is effected by use of hydraulically operated pumps, in which a piston is driven up and down by water from a distribution system, under control of a main piston valve also hydraulically operated; this piston operating a rubber piston in a sewage cylinder below; each unit containing two float-operated pumps to handle variable flows. At one zone, capacity 180,000 gpd, a lift of 20 ft. is obtained for 7.6 gal. of sewage for each gal. of water under 200 ft. head; at a second zone, capacity 160,000 gpd, 5.7 gal. of sewage is lifted 31 ft. for each gal. of water under 220 ft.; and at the third zone, capacity 24,000 gpd, 2 gal. of sewage is lifted 25 ft. for each gal. of water under 90 ft. head. The rising mains are 4" diameter.[D9-13]

Flow in pipe bends was studied in the laboratory of the University of Iowa by Yarnell and Nagler, from which they concluded that: (1) All bends act as obstructions to flow, resulting in additional loss of head. (2) With uniform velocity distribution in the approach channel to the bend, the velocities of the filaments along the inside wall of the bend are increased while those along the outside wall are reduced. (3) For a given pipe bend and quantity of flow, the head lost in the bend depends upon the velocity distribution in the approach tangent. (4) In a standard 90°, 6-in. pipe bend, for the same quantity of flow, with high velocity on the inside and low velocity on the outside of the approach pipe to the bend, the loss of head may be four times as much as would occur in the same bend when high velocity occurs on the outside and low velocity on the inside of the tangent leading to the bend. (5) Knowing the maximum difference in pressure between the inside and the outside of the bend, and the radius and size of the bend, it is possible to compute the mean velocity in the pipe, and, therefore, the discharge. (6) After a pipe bend has been calibrated, it may be used as a flow meter and discharges may be determined by measuring the difference in pressure between the inside and outside of the bend. (7) The losses in the pipe bends experimented upon appear to vary as the square of the velocity and not as the 2.25 power as suggested by some writers. (8) The fundamental laws that apply to closed conduit bends, also apply to open channel bends.[K9-1]

Paints for sewage works have been studied in Chicago, and samples subjected to raw sewage, aerated sewage, sewage gas, and to air and weather with some sewage gas present. Based on these studies, the Sanitary District uses for a priming coat black oxide of iron, with some zinc chromate as an inhibitor, mixed with tung oil varnish containing a small amount of heavy kettle-bodied linseed oil to increase adhesion. This varnish must pass hot water, cold water, hydrogen sulphide, ammonia, gasoline and fatty acid tests. Hot bituminous coatings, if properly constituted and applied, are the most resistant to sewage conditions of any of the coatings tried, but are rather difficult to apply and rather expensive. They should pass tests for chipping, sagging at 140° F, cracking at 0° F, brittleness, and machine oil. They should average at least 1/16 in. thick. Asphalt emulsions are not nearly so protective, but are about the only thing in common use that can be used where the steel can not be properly dried. The emulsifying agent should be such type as will readily evaporate (like ammonia) and cause the asphalt to solidify in spite of the moisture on the steel. In under-water work emulsions should be about twice as thick as hot coatings and somewhat thicker in all locations. In general, the emulsion should not flow at a temperature of less than 125° F, nor become brittle at low temperatures; after soaking in sewage for 7 days it should not rub off or markedly discolor the fingers when vigorously massaged.[C9-7]

Dangerous gases in sewers and sewage tanks should be provided against; in sewers by removing, half an hour before use, the cover of the manhole to be used and of the manhole next on either side; then test made for sulphuretted hydrogen by exposing moistened lead acetate paper for five minutes, for axphyxiating conditions by burning a safety lamp in the manhole for five minutes, and for inflammable gases by a suitable detector lamp. A life line should always be worn by the first man entering a sewer or tank until the safe condition of it has been established. On no account should smoking, striking matches or carrying naked lights be permitted in sewers or tanks.[D9-8]

B. O. D. of wastes—domestic sewage, and milk, pea and packing house wastes—and the effect of the pH of the dilution water thereon formed the subject of experimental work, which indicated that each of these may be expected to give higher B. O. D. values with bicarbonate dilution waters whose reactions are alkaline than with those whose reactions are acid. Also that pea waste and milk waste have maximum rates of biochemical oxidation with bicarbonate dilution water having an initial pH of 8.0; and that within the range of pH 7.0



Section of sewage pumping station.

to pH 9.0 the pH of the dilution water has little or no effect on the B. O. D. of domestic sewage or packing plant waste. [C9-5]

Chlorine feed proportional to the chlorine demand is secured by equipment developed by J. H. Harrington and A. Kilpatrick, of the Montreal filtration plant, and the General Supply Co. of Canada, for use in the Montreal plant. Water is pumped through a ½ in. copper pipe to a photo-electric cell cabinet and a continuous supply of orthotolidine is automatically fed into it on its way to the color comparator. In addition to the photo-electric cell, there are a control switch board, chlorine regulating equipment and emergency chlorine supply. The equipment is designed to secure remote control of several chlorine valves, for applying chlorine in either the chlorine room or the gate house, and through a wide range of flow; these valves being adjusted from either the chlorine room of the filter gallery by push buttons.[M9-5]

Chlorinating harbor water for protection of bathing beaches and shell fish areas from sewage was practiced in a large harbor on the Connecticut shore. Comparison of the harbor water when chlorination was employed and when it was discontinued for several days showed B. coli absent in 10 cc samples 58% of the time during chlorination, but only 25% of the time when this was discontinued; and present in 1% and 12%, respectively, of 0.1 cc and 1.0 cc samples. Comparing shell fish samples, scores of 5 or less were found in 80% of samples during chlorination and in only 45% at other times; and scores of 140 or up in 0% and 27.5% respectively. (Scores over 50 are considered objectionable.)[C9-9]

Heating digesting sludge at Essen-Rellinghausen by means of hot water has not been a success because the pipes became encrusted and the water consumption was too great, and the method has been discontinued in favor of a system of movable pipes such as had been found satisfactory at Hattingen, cooling water that has taken heat from the gas engines and the exhaust gases being passed in a cycle through the heating pipes. With this procedure up to 80% of the heat can be utilized, with a temperature approximating 100° C, without the pipes becoming encrusted.[D9-11]

Experiments with tanks containing windows to observe the **distribution of air bubble,** carried on by Kessener,[H6-3] showed that, with a row of diffusion plates along one side of the bottom, the air bubbles moved straight upward, the majority breaking on the surface nearly straight above the porous plate and very few were carried downward with the revolving flow. With paddles used for distributing the air, the air column was bent toward the middle of the tank, but good distribution was not accomplished. . . . When the paddles were reversed, moving with the sewage current induced by the air movement, the distribution of air was somewhat poorer than when the paddles moved against the current, and somewhat better than without paddles. The air bubbles produced by the brush mechanism were much more finely divided than with the direct air. The result was that a far smaller percentage of bubbles burst upon reaching the surface and a much better distribution of small air bubbles throughout the tank was obtained. The second striking thing was that the smaller bubbles carried downward rose very slowly and deviated from the most direct path with the least amount of cross-current.

A sludge sampling device designed by Dr. H. Bach, Essen, consists of a U-shaped pipe of aluminum, brass or other suitable metal, 2½ to 3″ diam., fastened to the bottom of a pipe long enough to reach the bottom of the tank to be sampled. The free end of the U pipe is fitted with a wooden stopper *c* which can be removed by means of a cord *d*. At the bottom of the U is an outlet onto which is screwed a cap *f*. For sampling sludge, lower the U with c and *f* both in place, until the free end of the U is at the depth at which it is desired to take the sample (measured by either the pipe *g* or the cord *d*), and pull out the stopper *c*. The sludge will rise in the pipe *g* to the level of the sludge in the tank. Remove the pipe slowly, and the sludge faling in *g* will flow from the U pipe, preventing sludge from entering at a higher level. By unscrewing the cap *f* the sample is drawn into a container.[C9-11]

Sludge sampling device.

Disposal by evaporation and soakage is required in the Union of South Africa, where the health authorities "are not prepared to allow any effluent, even though it be chemically and bacteriologically pure, to be discharged into a permanent stream except under very special circumstances. The alternative is to pass the effluent over a sufficient area of land, so that soakage and evaporation cause the effluent to be lost. How great the soakage and evaporation may be is shown at Klipspruit, where over 4,500,000 gallons of settled sewage a day are passed by broad irrigation (no underdrains) over about 1,000 acres of land, and only about 500,000 gallons per day actually run off the surface to be passed through percolating beds and over approximately 50 acres of land till it entirely disappears. The average chlorine (in chlorides) content of Klipspruit sewage is 25.0, and the average for the liquid run-off is 55.7, so that the concentration is approximately doubled by evaporation." The sewage is very strong, due to the scarcity of water and its cost—$1.00 to $1.25 per thousand gallons; which also is the reason for the extreme precautions taken to preserve the purity of the streams.

Irrigation flooding is preceded at Klipspruit by screens, ditritus tanks, roughing tanks, sedimentation and secondary sedimentation; while at other plants sludge digestion, sand filters and activated sludge are employed.[D9-5]

Equipment in treatment plant at Hagerstown, Md. (in service since May 2, 1933) includes:[H7-4; E7-1] Dorrco fine screen, 5′ diam., 4′ wide; 4″ Wood trash pump to pump screenings; grease removal tank 50′ x 10′ on top, 5′ deep, with air diffuser plates in the bottom; Simplex venturi meter, registering; Link Belt sludge collectors in two settling tanks; 3″ Domestic pumps in duplicate; 6 aeration tanks, 129′ x 16′ x 15′ deep, with two rows of air diffuser plates; duplicate Ingersoll-Rand centrifugal blowers, 1500 cfm capacity, driven by 75 hp electric motors; American Air Filters Co. air filter; Hardinge spiral scrapers in two 50′ x 50′ final settling tanks 10′ to 13′ deep; two 6″ centrifugal return sludge pumps; two Wright vacuum filters, 8.5′ diam. by 10′ long; two Ingersoll-Rand vacuum pumps; two La Bour filtrate pumps; a vacuum filtrate receiver; a Jeffries paper shredder; a 3″ and a 4″ Domestic centrifugal pump for sludge handling; lime and ferric chloride mixing tanks; motor-driven paddlewheel agitators for sludge and pulped paper; also recording air flow meters, discharge-pressure gauges of mercury manometer type, air-filter differential gauge, and other small

equipment. Capacity, 8 mgd preliminary treatment, 6 mgd full treatment. Cost (including original 1924 construction) $320,000, exclusive of land. Operating cost, $2,600 per month, or $35 per mg, of which sludge filtering takes $9.50 to $11 per mg of sewage treated.

Bibliography of Recent Sewerage Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

C *Sewage Works Journal*
9 *July*
1. *t.* Settling and Compacting of Activated Sludge. By Willem Rudolfs and I. O. Lacy, pp. 647-675.
2. *t.* Bacterial Numbers in Activated Sludge Mixtures. By H. Heukelekian, pp. 676-688.
3. *t.* Adsorption and Flocculation as Applied to Sewage Sludges. By A. L. Genter, pp. 689-720.
4. *t.* Tendencies in Standards of River and Lake Cleanliness. By H. W. Streeter, pp. 721-733.
5. *t.* Relation of the pH of Dilution Water to the Biochemical Oxygen Demand of Various Wastes. By J. M. Holdesby and Wm. L. Lea, pp. 734-741.
6. Two Years' Operating Experience of Modern Chemical-Mechanical Sewage Treatment, Dearborn, Mich. By Mark B. Owen, pp. 742-761. Editorial on same, pp. 805-807.
7. Paints for Sewage Works. By W. T. McClenahan, pp. 762-773.
8. Experiments with Inlet Devices for Sedimentation Tanks. By George E. Hubbell, pp. 774-783.
9. Chlorine Disinfection of Sewage. By Warren J. Scott and Le Roy W. Van Kleeck, p. 784.
10. Tipping Bucket Sludge Meter Developed at Aurora, Ill. By Walter A. Sperny, pp. 797-802.
11. A Simple Device for Sampling Sludge. By Dr. H. Bach, pp. 803-804.

D *The Surveyor*
9 *July 13*
1. The Oxidation of Gas Works Liquors in Admixture with Sewage. By A. Key and W. Etheridge, pp. 29-30.
2. Experimental Work on the Secondary Sludge Problem. (Discussion of D8-2), pp. 31-33.
3. The Solution of Oxygen from Air Bubbles. (Discussion of D8-3), pp. 33-34.
4. Treatment of London Sewage, p. 38.
5. Bio-Chemical and General Research Organization at Johannesburg, So. Africa. By H. Wilson, pp. 45-46.

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6. Activated Sludge and the Air Bubble, pp. 49-50.
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Sanitation for Rural Sections in Maryland

During the latter part of 1933 the Maryland State Department of Health, cooperating with the United States Public Health Service, organized a Community Sanitation Program in the counties for constructing sanitary privies in the rural sections and in those towns in which the possibility of installing sanitary sewerage systems seemed remote. The records of the Bureau indicated that, of the total population of the State outside of Baltimore City, 338,000 persons are served by sewers, and that 524,500 live in sections without sewerage facilities. The number of separate properties without individual or community sewerage facilities is estimated at 104,900.

The State was divided into four districts, with a district supervisor in charge of the work in each district and a local supervisor to handle the work in each county under the direction of the director of the State Department of Health as director of the Community Sanitation Program, and an assistant director in charge of the work. A training center for the men who are to supervise the local projects in the counties was established at Rockville by the United States Public Health Service, where intensive training was given on the construction of the types of privies to be built.

This program applies particularly to private homes, schools, filling stations, tourist and labor camps, dairies, canneries, oyster and crab houses, mining camps and small communities without sewerage facilities. The work will give employment to men on the unemployed list, who will be paid out of money appropriated from Federal funds. Lumber and other material used on this project must be provided by the owner or occupant of the property.

As a great many schools in the counties are without sanitary toilet facilities, a special effort was made to have such conditions improved. The county superintendents of schools were notified that school sanitation projects should be included in the local CWA program. Work on the school properties was well under way in a number of counties by the end of the year.

Comparative Cost of Concrete and Corrugated Metal Culverts

In a contract for which bids were received April 4th by the Colorado State Highway Department were included corrugated metal pipe culverts of 24", 36", 48" and 72" diameter; and for the last size alternate bids were received for reinforced Class A concrete. There were 486 lineal feet of this size culvert, for which one contractor bid $15.50 a foot for metal culvert and five bid $16.

A concrete culvert would require 80 cu. yd. more rock excavation and 20 cu. yd. more common excavation than would a pipe culvert, and 395 cu. yd. of concrete with 38,600 lb. of reinforcing steel. All the bidders asked more for the concrete culverts, the low bidder $21.22 per lineal foot as compared to $16 for c.m.p., including the additional excavation; or $21 for the concrete alone. This is an increase of 31+% for the concrete regardless of the increased excavation necessary. The difference was much greater in the other bids, running as high as a 100% increase.

New twin tunnel route from Oakland Bay bridge to Contra Costa County. 1—New tunnel road. 2—West portal of tunnel. 3—East portal. 4—Old tunnel road. 5—Line of old tunnel. 6—Line of new tunnel. 7—City of Berkeley. 9—Broadway. 10—Fortieth Street. 11—San Francisco-Oakland Bay bridge.

A California Double-Bore Highway Tunnel With Unusual Features

WORK is just beginning on the "Broadway low-level tunnel project" which will connect the California East Bay cities with the Contra Costa County suburban area by a double-bore tunnel through the Berkeley hills. There is already a route giving such connection, but it contains many curves of about 50-foot radius, with a total of 5,000 degrees, the tunnel approaches are on a 6 per cent grade, the tunnel has only 17 ft. clearance between side walls. The new route of which this forms a part will save 10 miles in distance, has no curves sharper than 800 ft. radius, with a total curvature of less than 500 degrees, and the maximum grades are 5.1 per cent—4 per cent through the twin tunnels.

The work is being carried out by a joint district consisting of Alameda and Contra Costa counties. The estimated cost is $3,752,000, of which the state will furnish $700,000, and a PWA grant of $1,095,000 has been obtained, and the remainder will be obtained by sale of bonds of the joint district.

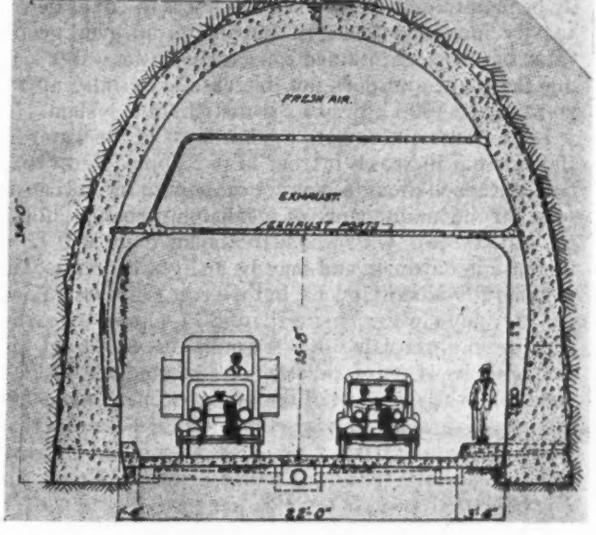
The main part of the project is 2.82 miles long, consisting of a highway leading from the intersection of Broadway and Keith Avenue, Oakland, northeasterly up Temescal canyon and through a double-bore tunnel 3,168 ft. long, emerging north of Fish Ranch Road in Contra Costa county.

The Tunnel

The tunnel will consist of two bores, 15 ft. apart at the portals, 100 ft. apart through most of their length; there being three pedestrian cross-connections between the bores. Each bore will have a 22-ft. roadway and a 3-ft. sidewalk and a height of 30 ft., of which the top 15 ft. will be occupied with exhaust and fresh air ducts. They will be concrete lined throughout, and mechanically ventilated. Fans will be installed in a reinforced concrete building at each portal having an input capacity of 1,500,000 cu. ft. of fresh air per minute and a similar exhaust capacity. Carbon monoxide detectors and recorders will indicate the degree of pollution at all times and serve as a guide to the operation of the fans. Electric illumination and traffic control devices are provided.

A feature of the construction will be the light transition structures at each portal. Experience at other highway tunnels has shown that the eye does not adjust itself to the difference between the intensity of sunlight and the maximum practical artificial illumination in a tunnel with sufficient rapidity to insure good vision when vehicles are traveling at high speeds. There has therefore been provided a transition section about 200 feet in length, which consists of an overhead louvre device supported upon the portal approach walls. These overhead louvres prevent direct rays of sunlight from falling upon the roadway area and thus provide a lighting of intermediate intensity as compared with the direct sunlight outside and the artificial illumination inside the tunnel.

Thos. E. Caldecott is president of the board of directors of the Joint Highway District. Harry M. Stow is secretary and Henry L. Hinman treasurer. Wallace B. Boggs of Oakland is the district engineer.



Cross-section of West bore.

Prevention of Main Corrosion by Lime and by Sodium Compounds

PREVENTION of corrosion of water mains has a distinct money value, although it is difficult to assign a definite value to it. It not only lengthens the effective life and increases the capacity, but it reduces the annual costs. In Baltimore the operating and maintenance costs for pipe lines owned by the water bureau for 1932 were $8.41 per mile less than for 1920, when corrective treatment was not used. Conditions other than alkaline water enter into this cost reduction, such as electrolysis control, etc., but its non-corrosiveness is a most important factor.

Reduction of corrosion in existing mains can most satisfactorily be accomplished only by treatment of the water. It is admitted that complete elmination of corrosion is not brought about in this manner, but the value of the reduction where the water is fairly corrosive greatly exceeds the cost of treatment. When it is possible to deposit rust formed in alkali waters, corrosion will be checked; and if an alkaline material can be precipitated on the pipe with the rust, a more or less uniform dense, compact, protective layer of hydrated ferric oxide and the alkali salt (assume calcium carbonate) will adhere to the metal. This rust deposition must contain calcium carbonate in the ratio of 0.1 part of Ca to 1 part of iron, if excessive corrosion and pitting are to be stopped.

To control corrosion, it is necessary to eliminate all factors which cause a breakdown of this protective rust film formation, of which "aggressive" carbon is the factor most commonly found in neutral waters. Removal of this corrosive agent is accomplished by absorption in lime water, with a resultant precipitate of calcium carbonate if the concentration is above the solubility point.

This corrective treatment is effective only when utilized constantly at the calcium carbonate equilibrium point. The coating produced by this treatment can easily be maintained at egg-shell thickness in either new or heavily incrusted lines. In Baltimore, an average pH value of 7.9 is maintained constantly in the water leaving the plant and does not decrease materially at any point in the 1500 miles of the distribution system.

Lime treatment adds to the hardness of the water; in Baltimore it increases it from 44 to 52 ppm. Neutralization of carbon dioxide is practicable with use of caustic soda for the maintenance of a calcium carbonate film in the pipe system, with which treatment there will be no increase in hardness and may be a slight decrease. This is generally advantageous, but the cost is greater. Based on Baltimore water, neutralizing 11.4 ppm of carbon dioxide to a pH value of 7.9 would cost $1.84 per million gallons if solid caustic soda is used, or $2.22 if soda ash, while the cost of the lime treatment was $0.28. Expressed in another way, there would be an increase in the tax rate of 0.65 ct. per $100 assessment if caustic soda be used and 0.82 ct. if soda ash; or about 6 cts. and 7 cts., respectively, per capita per year.

The addition of 8 ppm of hardness would involve additional costs in the household for soap, and certain industries such as laundries and ice manufacturing plants which soften their water would have the cost of this increased. Extra cost of soap in the household caused by 8 ppm is estimated at about 8 cts. per person per year. The extra cost to a commercial establishment using 30,000,000 gal. per year was $196.76 per year; to a large manufacturing plant having a yearly steam capacity of 192,000,000 pounds it was $295.

These calculations are roughly approximate, but it would appear that the saving to householders by the soda treatment is just about offset by the additional cost of such treatment. It does not appear to be justifiable under these conditions to tax a community for the benefit of its industries, particularly as the added softening burden in relation to plant overhead and cost of process operation is very slight. This is usually reflected in consumer price, which is a fair proposition, as the person directly benefitting pays the bill. It is believed, therefore, that corrective treatment with lime produces a water of the most value to the greatest number of people.

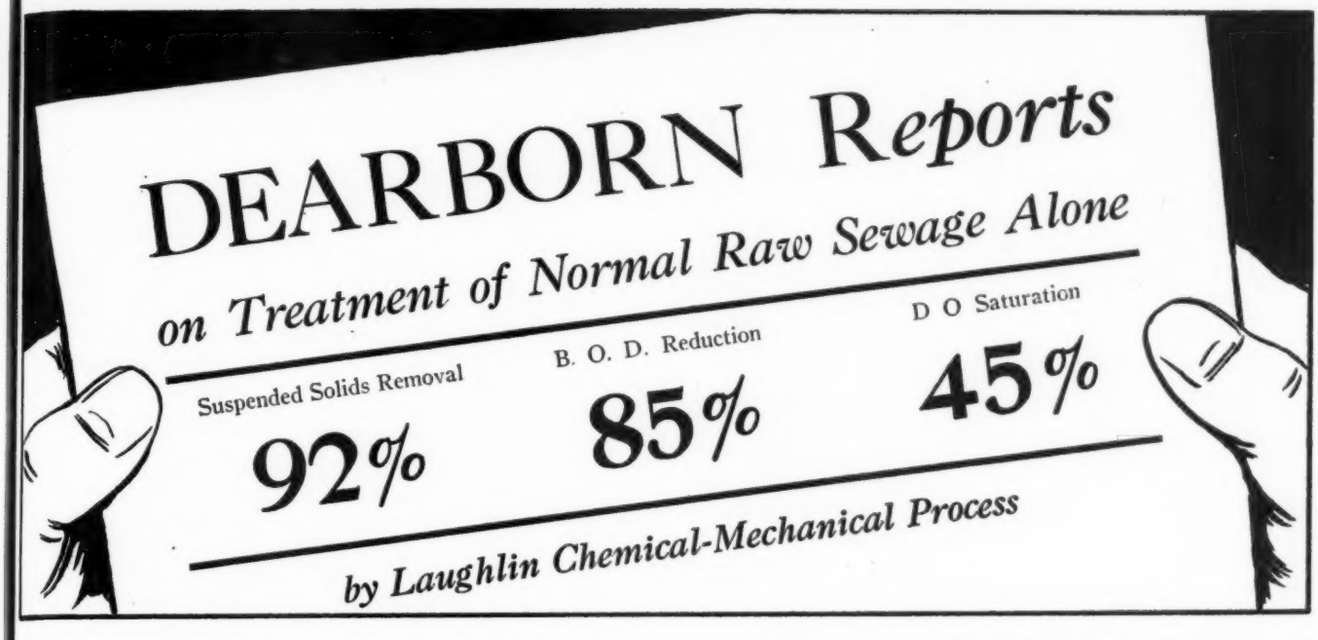
The above is condensed from a paper before the Virginia Section of the American Water Works Association by Edward S. Hopkins, principal assistant chemist, Bureau of Water Supply, Baltimore, Md.

St. Paul Reduces Water Rates

The report for 1933 of the St. Paul, Minn., water commissioners contains the folowing interesting statement:

"Early in the year the Water Board, realizing the need at the time of furnishing water at the very minimum of cost, caused a very thorough study to be made of the water rates and the net returns of the Water Department. As a result of this study, beginning May 1st, the Board ordered a reduction of 10 per cent in all water rates. This has meant a saving to water consumers of, very approximately, $70,000 in seven months. In making this reduction the Board realized that such a reduction in the receipts of the department, which will probably be more than $100,000 annually, will require that all extensions and capital outlay must be held to the very minimum. To be successful, such a policy of returning to the water users all or practically all of the net profits of the department, requires that all concerned be thoroughly acquainted with the fact that all capital outlays, including the purchase annually of meters, service pipes, equipment, cast iron pipes, etc., must be limited to the reduced net operating profits or require the issuance of more water bonds. The Board felt that the unusual times justified, for the present at least, the curtailment of improvements so that the surplus could be returned to the water users."

During 1933 the total revenue from sale of water was $869,416, from hydrant rental and other, $107,280; total expenses of operation, $438,990, and total fixed charges, $463,545.



FOR upwards of two years engineers and municipal officials have been watching Dearborn's West Side plant. ¶They have been asking whether Dearborn's new Chemical-Mechanical treatment of sewage, including liquid wastes from steel and motor plants, would accomplish what no other known system could handle so successfully. ¶Now—Mr. Mark B. Owen, Dearborn's Superintendent of Public Works, tells the story—a story that will win the interest of every engineer, municipal official and student of public economy. ¶At the right we give you the highlight results of the first two years' operation. Mr. Owen's report concludes:

> *"The results obtained and the cost of operation during the first two years have not only been satisfactory but highly pleasing to the officials of the City of Dearborn. The quality of effluent produced has exceeded that expected two years ago. The cost of operating has been within the estimated amount when the plant was ordered built."*

Whether or not you have read Mr. Owen's report "TWO YEARS OPERATING EXPERIENCE OF MODERN CHEMICAL-MECHANICAL SEWAGE TREATMENT, DEARBORN, MICHIGAN" in July Sewage Works Journal, you will undoubtedly welcome a reprint of this article in convenient booklet form. ¶If a copy hasn't reached you by the time this advertisement appears, write us and we'll see that it goes to you promptly.

TWO years of operation showed a sewage treatment and sludge disposal, composite volume 1424 million gallons (1294 million of domestic sewage, 130 million sludge from sedimentation plant handling 16 m.g.d. of sewage).

•

17,792 tons, 60 to 65% moisture, vacuum filter cake disposed of satisfactorily without nuisance. Sludge dewatered on vacuum filters with continually improving results per square foot of filter area during the period.

•

Total cost of operation, maintenance, treatment of sewage and disposal of sludge for two years, was $77,785.

•

Plant capacities: Sewage pumping 75 m.g.d. Sludge disposal and chemical feeding equipment 40 m.g.d. Laughlin Clarifiers 8 m.g.d.

•

Well clarified effluent discharged at pH 7.8, practically free from organic settleable and suspended solids.

•

Architecture in keeping with that of Ford's early American village.

•

In the last six months of this operating period one Laughlin Magnetite Clarifier treated 1.74 m.g.d. of raw sewage alone. DURING THIS TIME AN EIGHTY-FIVE DAY RUN UNDER CONDITIONS MORE TYPICAL OF OTHER INSTALLATIONS, GAVE AN AVERAGE B.O.D. IN THE EFFLUENT OF 20 p.p.m.—A REDUCTION OF 85%.

Bear in mind that these results were achieved in a plant not designed to secure such a high degree of treatment. Performance far exceeded fair expectation, and strikingly emphasizes the flexibility of the general methods employed.

FILTRATION EQUIPMENT CORPORATION

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Waterworks Topics

Waterworks Requirements for Minimum Insurance Rate

By George Hawley

Even a small city, which does not meet the requirements for adequate fire protection as adopted by the insurance authorities, may pay out as much as $10,000 a year in additional premiums, over and above what would have to be paid if the requirements for fire protection were fully met. Some of the requirements, as applied to Texas municipalities, were discussed by the author at the 16th Texas Water Works Short School:

Supply Available—Provision must be made for 110 gallons per capita; and if the supply is from wells, there must be above-ground storage by reservoir of at least 50,000 gallons, or with an elevated tank, the storage must be based on 10 hours supply at 110 gallons per capita per 24 hours, and the bottom of the tank must have a minimum elevation of 100 feet.

Pumps—Pumping equipment must consist of a minimum of two 500-gpm pumping units, or equivalent, and all pumping equipment must be capable of producing its rated capacity with a pressure of not less than 60 pounds at any fire hydrant in the mercantile district, and without regard for the elevated tank or standpipe. Duplicate power is necessary.

Distribution System—Main sizes in the mercantile district cannot be less than 8 inches in diameter; in the residence district, 6 inches. Hydrants must be located at each street intersection, both in front and in rear of business blocks, in the business district; and in the residence sections, at approximately every other street intersection, or 600 feet apart.

In discussing this brief paper, J. Bryan Miller, City Manager, Jacksonville, Texas, stated that Bryan, Tex., had a key insurance rate of 45 cents in 1924. At that time a definite program of improvements was worked out and adopted, with the result that in 1929, the rate at Bryan was 19 cents. In Jacksonville, the rate had been reduced in three years from 44 cents to 35 cents, and the program now under way, when completed, will reduce the rate further to 28 cents.

Faults in Earthen Reservoir Embankments

FIFTY earthen reservoir embankments in England have recently been examined by P. B. Glendinning, in accordance with a Reservoirs Safety Provisions Act, and recommendations of the Institution of Civil Engineers, and quite a number were found not to satisfy the conditions of those recommendations. In a paper before the Institution of Water Engineers on March 16th, Mr. Glendinning described some of the defects found.

"The most common fault found was insufficient freeboard, that is to say, there was too little difference between the level of the top of the bank and the top of the waste weir. In some cases sufficient allowance had not been made in the original design, but more often the bank had settled somewhat through consolidation and had not been made up to its original level.

"Whatever the nature of the material of which earthen embankments are made, there must be more or less consolidation in the course of time and consequently a shrinkage. When constructing a new embankment, the finished level should therefore be left higher than what is intended to be the permanent height."

Flashboards or other methods of raising the water level should not be used if or when such level would leave insufficient freeboard. In calculating the necessary freeboard, consideration should be given not only to the maximum possible depth of flow over the spillway but also to the height of waves and their velocity, which will depend upon the fetch above the embankment.

Another defect is failure to carry the puddle trench down to an impervious stratum, or below the level of fissures in rock, causing leaks.

Waste weirs should not be constructed directly over a puddle, which is sure to settle and cause cracks in them; but they should be founded on solid material throughout their whole length. The puddle wall should not join the side wall of the waste weir with a straight butt joint, for water will find its way through this.

The channel for removing the waste weir overflow must be ample. The water enters the channel with comparatively low velocity, which increases as it flows down the usually steep grade, and again usually diminishes as the grade flattens at the bottom. The cross-sections of the channel should be designed with these changing velocities in mind, remembering however that the changes do not occur until after a change in grade has had time to produce its effect. Sudden changes in velocity, produced by abrupt changes in grade or cross-section, or sudden changes in direction of flow, cause powerful erosive tendencies which it is generally desirable to avoid.

"All outlet culverts and pipes leading out of a reservoir should be solidly supported over their whole length. Pipes should not be laid spanning a trench, the puddle in which may consolidate and cause a sag in the pipe, which may lead to fracture, or at least a partial opening out of joints. All pipes and culverts through an embankment ought to be provided with sufficiently large collars to effectively prevent water creeping along the outside."

Operating a College Swimming Pool

In a talk before the Texas Beach and Pool Association, E. W. Steel, professor of Sanitary and Municipal Engineering, Texas A. & M. College, touched on the operation of the college swimming pool, as follows:

"We have a new pool now in operation at A. & M. College, which has a 235,000-gallon capacity, with recirculation equipment, four pressure filters, alum coagulation and chlorination treatment, and ammoniator in the case of the use of chloramine. We have algae trouble in this pool, probably due to the source of the supply, and the algae come through the filters. The water in the pool will turn to a greenish color overnight in spite of the fact that the pool is enclosed in a building and not exposed to sunlight. We cannot use copper sulphate to destroy the algae because of the high alkalinity of the water and the use of copper sulphate would give the water a cloudy appearance. We have found that the only method by which we can keep the algae down is with chlorine. We use 0.5 p.p.m. excess chlorine, and sometimes have to increase the dosage to 0.6 or 0.7 p.p.m. Of course, due to the use of the increased chlorine dosage for algae control, we get very good bacteriological results when the water is tested.

"The pool is equipped with all the sanitary devices except the foot tray for the control of athletes foot. It has been recommended that the college purchase one of these trays, but funds have been insufficient up to the present."

The Water Wheel

Following are the essential features of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form and condensed and interpreted.

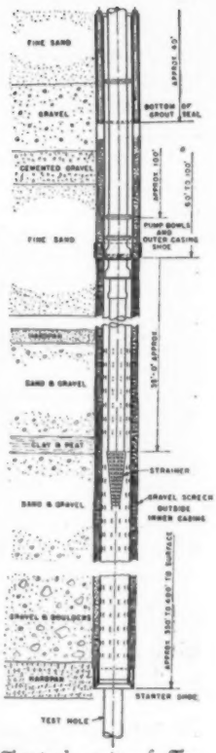
UNDERGROUND supplies of water were unaffected by the drought of 1930. "As a result of great improvements in methods of drilling, developing and finishing of wells and in pumping machinery and power installations, it has become more feasible and less expensive to pump underground water." But there is danger of overdrawing and temporarily ruining a supply. To prevent this, or restore an overdrawn supply, legal control is necessary of both construction and operation of wells.[E9-4]

Large wells were constructed by Tacoma, Wash., in 1932 to supplement its surface supply. Five wells, 26"-38" casings with gravel between, 300' deep, yielding 23.6 mgd with a 60' drawdown, cost $64,914 for construction, $44,111 for pumps and installation, $8,068 for buildings, $15,539 for connecting pipe lines and $9,197 for engineering. The annual cost is: depreciation, interest, etc., $13,540; operating labor, $432; maintenance and supplies, $500. Power current costs less than 1 ct. per 100 cu. ft. Ordinarily the wells will be operated only for several hours each day during the summer months of each year. Wells are free from the hazards of a 43-mile pipe line from a distant surface supply, ice and snow troubles at the intake, floods at river crossings, etc.; the quality of the water is better; the capital investment was relatively small; failure of equipment at any one well would not be serious.[A9-4]

The **Boston Metropolitan Water Supply** makes use of eleven distributing reservoirs of from 1.0 to 1792 m.g. capacity; ten storage reservoirs and dams of capacities from 167 to 64,968 m.g.; ten standpipes of capacities from 133,364 gal. to 2,500,000 gal. and 24 to 100 ft. diam. These give total storage capacities of 2,790.1, 80,753.6, and 8.58 m.g., respectively.[B8-2]

The **Ware River Intake Shaft** of Boston's Quabbin Aqueduct system has many unique and interesting features. This shaft, 260 ft. deep, diverts to the tunnel, river flow in excess of 85 mgd. up to 3,100 cfs., and such diversion is made automatically. Under certain conditions, 400 cfs. will drop this entire depth into a pool only about 15 ft. deep, and to dissipate the energy in a thin conical jet at the bottom, the water, entering through four butterfly valves, is discharged tangentially against the side walls of the shaft at an angle of about 30° with the horizontal; the entire shaft is lined with cast iron plates in which are projecting ribs which form helical vanes like a six-pitch screw thread, which insure the maintenance of the rotary motion of the falling water throughout the entire drop, the centrifugal force pressing the water against the shaft wall. A vacuum equivalent to about 25 ft. head may be created in the shaft. To maintain atmospheric pressure in the building under fluctuations of the water level, windows in the building are equipped with swinging louvers swinging freely in both directions. For automatically controlling the valves, priming of siphons and other operating features, use is made of various ingenious electrical, mechanical and hydraulic devices, which have been tested out and have been successfully placed in completely automatic operation.[L9-1]

An **articulated core wall** of concrete 146 ft. high grouted into the rock foundation is an unusual feature of the Priest dam (Calif.), built in 1922.[L6-3] It was expected that during construction and subsequent consolidation of the rock and earth fill of the dam, unbalanced pressures on the core wall would displace it slightly. To avoid rupture resulting from such displacement, the wall was divided into panels by vertical deflection joints of the ball-and-socket type, spaced 50 ft. on centers, and by horizontal contraction joints 16 ft. apart, all sealed with copper strips. Since completion, the loose rock fill downstream from the core wall has settled 9 ft., the earth on the upstream side, placed by the hydraulic method, has settled 2½ ft. and the core wall has deflected downstream a maximum of 2½ ft. For the ten years since construction the leakage through the dam (measured by weirs) has remained almost constant at 0.34 cu. ft. per second, and causes no anxiety to the engineers.



Typical unit of Tacoma water development.

The **Quabbin aqueduct tunnel** (Boston Metropolitan Dist. water supply) is [L7-1] nearing completion. It is 11' wide by 12' 9" max. height. Capacity 1,200 mgd. from Quabbin to Wachusett reservoir; or nearly 2,400 mgd from Ware river (nearly midway between them) to both reservoirs simultaneously. Water has been flowing from Ware river to Wachusett for three years. In the whole 25 miles of tunnel, only 1,970 ft. of timbering was required. In some stretches, aggregating about 3 mi., rock fell because of slacking of material in seams when exposed to the air, and here the roof was given 3 coats of gunite to a total thickness of about an inch, which obviated use of timbering or of thicker masonry.

Coarse aggregates in concrete for the Madden dam were studied by the engineers, and conclusions reached [L7-2] that:

"1. The compressive strength of concrete is not greatly affected by a rather wide variation in the gradation of the coarse aggregate as long as the water-cement ratio remains constant and the mix is workable.

"2. For identical water-cement ratios, the cement factor is greater for unbalanced grading of coarse aggregate than for uniform grading.

"3. For mixes of average consistency (with a slump of from 3 to 4 in.) and of identical water-cement ratios, the cement factor decreases as the maximum size of the coarse aggregate increases."

Cementation of reservoirs to prevent or cure leakage is increasing in England.[D6-2] Costs 25% to 50% as much as cut-off trench and equally effective. Cheapest method of sealing leaks through permeable strata and allows use of reservoir during repairs. A concrete dam

in Spain leaked through underlying dolomite 214 mgd; grout was pumped through bore holes to a maximum depth of 1,400 ft.; in fissures 3″ or more wide melted asphalt was used; pressure used up to 110 atmospheres. When work stopped in 1931 because of revolution, 82% reduction in leakage had been made, 40,000 tons of cement used and 800 tons of asphalt.

An earth dam in North Wales, 42′ high, built 60 years ago, was cemented-grouted in 1933. Crest had settled 3′ and downstream face bulged, leakage 120,000 gpd. Cement injected through vertical holes in puddle core and all leakage stopped in 6 weeks.

Reservoir construction in El Paso, Tex.,[DD7-11] cost $12,800 per m.g. for two 4 m.g. masonry ones; $11,700 to $17,000 per m.g. for three cut and fill ones of 2.6 to 11.6 m.g. capacity. Concrete roof slabs should not be tied to walls and girders or temperature expansion and contraction (135° range in a roof) will cause rupture of roof or wall. Roofs should have expansion joints which are water-tight and which will yield to pressure. Better than road expansion joint material is a crimped strip of copper or lead in the joint, covered with bitumen. Expansion and contraction in tank floors negligible and joints unnecessary.

Meters damaged by hot water in Los Angeles totaled 47,084 in 9 years, or 42% of those removed for failure to operate. The cost of changing, repairing, testing etc., such meters in 1932-'33 averaged $3.34 per meter. When subjected to a temperature of 146° F. for 15 minutes, hard rubber meter pistons swell and warp slightly. Manufacturers have endeavored for some time to produce a piston that will withstand higher temperatures, and Los Angeles has tested five different makes of such at 212° and 280°. Only one make failed to develop defects, and this one is very brittle. If a satisfactory heat-proof piston can not be made, meter protection valves should be used if they can be perfected, these releasing hot water through a fusible plug if such water should reach the meter. They are free from the danger of check valves.[A7-12]

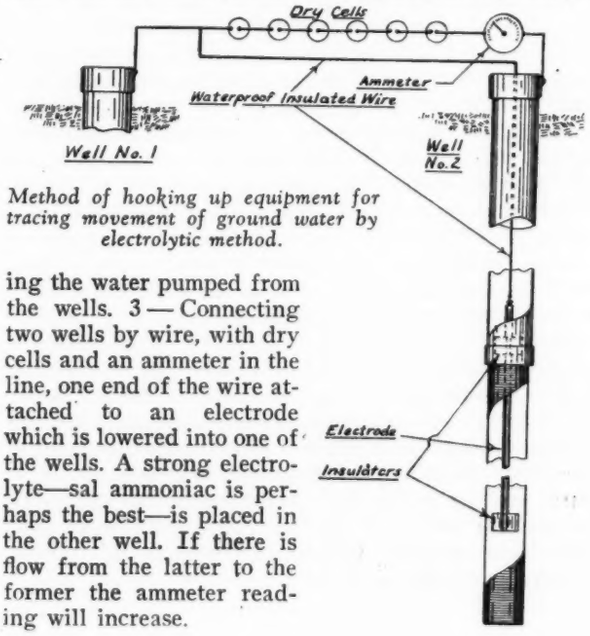
Tightness of steel pipe 18″ diam., 1132′ long, laid under Cumberland river, with flexible couplings, after a year's service was tested under 130 lb. pressure.[F9-2] Leakage in 42 hrs. was 4,338 gallons, measured by ⅝ in. meter with "gulper." A similar test when constructed showed no leakage that meter would measure 24 hrs.

Protecting pipe from traffic impact was effected by the East Bay Municipal Utility District (California) which laid nine 6″ c.i. pipe lines across a main thoroughfare, each encased in 12″ corrugated pipe for 30′ of its length under the roadway.[F9-4]

Coatings for steel pipe are selected by Los Angeles by consideration of the following points:[A7-1] *Hot Applications:* Whether suitable for dipping or brushing. Brittleness at temperatures of storage and use of pipe. Adhesion to pipe surface. Softening and sagging from heat of sun. Applied with or without priming coat. Tendency to form corrugations, bubbles or lumps when dipped. Type of dip kettle available—vertical or horizontal. *Cold Black Paints:* For brush, dip or spray application. Drying time. Taste, if for inside of pipe. Thickness or number of coats necessary for complete coating. Will it run when heated by the sun? Will it adhere if applied to a wet surface? In a recent case, 2700′ of 36″ riveted pipe, they also considered resistance to galvanic action, to shrinkage of adobe soil (which adheres to outside coating and may pull it off in shrinking), to the sun's heat during exposure, and to abrasion or deformation by stones in backfill. They adopted a triple treatment: (1) hot dip coating of well-known brand of bituminous material; (2) two coats of hard coal tar enamel applied in the field, to give hard protecting surface and help resist moisture; (3) a 6″ layer of washed sand completely surrounding the pipe to remove it from galvanic action of soil strata and prevent damage during backfilling and from adobe.

Main failures in London, England, due to insufficient cover, were so numerous under modern traffic conditions that the Metropolitan water board, owning 7,200 miles of mains, has found it necessary to relay 54 miles, at a cost of over $1,000,000, during the last ten years. How shallow the cover was may be judged by the board's recommendation "that all pipes up to 21 in. diameter shall be laid at a depth of not less than 3 ft., and that for pipes from 22 in. to 33 in. diameter the depth shall be not less than 3 ft.. 6 in., while for larger sizes it is required that there shall be at least 4 ft. of cover above the pipe." Other causes of failure mentioned are vibration, insufficient anchorage, bends, excessive depth, defective joints, water hammer, frost, earthquakes and lightning, internal and external corrosion, tuberculation and electrolysis. Subsidence is sometimes due to the washing out of soft soil on which pipes are bedded in rock trenches on steep grades; to prevent which, concrete cross walls have been built about 100 ft. apart carried above the top of the pipe.[D9-4]

Direction of **flow of ground water** is ascertained by sinking three wells at the angles of an equilateral triangle [W7-1]—more if greater definiteness of information is desired—and noting the flow from each to the others of some material soluble in water. Three materials are convenient for use: 1—Dyes, detected by color. Dye is dissolved in a pail of water, which is poured into a small pipe which extends nearly to the bottom of the well, followed by enough water to ensure that it all leaves this pipe, the other well being pumped during and after this. The dyes generally used are fluorescein, eosine or other fluorescent organic dye. 2—Salts of sodium, calcium, lithium, ammonium nitrate or ammonium chloride dissolved in water and applied in the same manner, their presence being detected by analyzing the water pumped from the wells. 3—Connecting two wells by wire, with dry cells and an ammeter in the line, one end of the wire attached to an electrode which is lowered into one of the wells. A strong electrolyte—sal ammoniac is perhaps the best—is placed in the other well. If there is flow from the latter to the former the ammeter reading will increase.



Method of hooking up equipment for tracing movement of ground water by electrolytic method.

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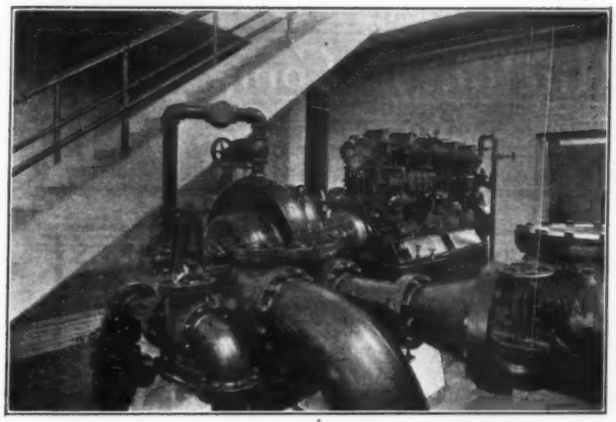

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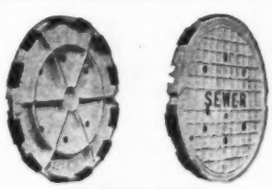

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Handling chlorine has its peculiarities and risks. If more than the rated contents of a cylinder be placed in it disastrous rupture may occur when the temperature rises to even room temperature. At temperatures above 194° steel burns in dry chlorine. Showers for removing leaking chlorine are not only ineffective but constitute a hazard unless operated in conjunction with an adequate forced ventilation system. Machine plugging is usually due to atmospheric moisture entering the chlorinator during cleaning or shut-downs, the chlorination of lubricants or cleaning solvents left in the machine; or to condensing liquid chlorine redissolving waxes deposited from gasoline chlorine. Grain or denatured alcohol and ether, if left in a chlorinator even in traces, will be converted by interaction with chlorine to solid waxy hexachlorethane. Advice for handling in its various details is given by the author.[F9-1]

Increasing consumption by advertising is sometimes advocated, but the water industry is one devoted to "rendering a service" and not "selling a commodity" and "it is the duty of the industry to render the service at the least possible cost to the consumer; an increase in the consumption per head might reduce the cost per gallon supplied, but it would certainly increase the quarterly rate paid by the consumer."[D9-5]

Low consumption rates are responsible for considerable under-registering of meters. The bulk of the use of water in private houses is apparently at a rate of 0.5 to 1.0 gal. per minute. In Hartford, Conn., in houses equipped with tank toilets, 27 to 50% of the total consumption is at rates less than 1 gpm., and 33 to 78% less than 2 gpm. With allowed variations of ⅝ in. meters, 5 to 10% of the total input into a distribution system can be "estimated as lost because of the improper operations and limits of the meters. . . . One has only to convert this percentage into terms of revenue to determine the value of meter research work."[A9-1]

The cost and revenue of 50 water works plants as reported to the Detroit water department, show wide variations. The figures given are total expenses (production plus fixed charges) and revenue per 1,000 cu. ft. The total expenses vary from a maximum of 2.912 cts, at Saginaw, Mich., to a minimum of 0.298 at Milwaukee. Wis. The revenues vary from a maximum of 2.869 at Saginaw to a minimum of 0.710 at New York City (0.707 at Detroit in 1932 but 0.736 in 1933). The revenue exceeded the total expense in all but 7 cities: the excess being 0.1 to 0.5 cent in most cases, with a maximum of 1.022 in Atlanta, Ga.[A7-25]

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *t*, technical article.

A *Journal, American Water Works Association*
9 *July*

1. A Meter Department Research Laboratory. By H. W. Niemeyer, W. F. Lebo and H. G. Horstman, pp. 819-830.
2. Inserting Gate Valves in Water Mains Under Pressure. By Charles Streithof, pp. 831-833.
3. Installation and Maintenance of Fire Hydrants. T. A. Storms and C. H. Becker, pp. 834-843.
4. The Development of Large Capacity Deep Wells for Tacoma, Wash. By W. A. Kunigk, pp. 844-857.
5. The Training of Operators of Water Treatment Plants. By R. D. Bates, pp. 858-867.
6. The Importance of a Water Waste Survey in a Gravity System. By Laurence C. Hough, pp. 868-873.
7. The Fort Peck Dam on the Missouri River. By Thomas B. Larkin, pp. 874-877.
8. Ammonia-Chlorine Treatment of Water in the Pacific Northwest. By Carl E. Green, pp. 878-883.
9. The Significance of Mineral Matter in Water. By P. L. Hibbard, pp. 884-890.
10. Protective Coatings for Pipe Lines. By Kenneth Shibley, pp. 891-901.

11. Sketch of the History of Water Treatment. By M. N. Baker, pp. 902-938.
12. Typhoid Fever in the Large Cities of the United States in 1933, pp. 939-949.

D — *The Surveyor*
9 — *July 20*
1. Cheltenham Waterworks Alterations and Extensions, pp. 61-62.
2. *n.* Water Supplies and the Drought, p. 70.
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3. London's Water Supply. (Annual report), p. 77.
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4. Failures in Steel and Cast-iron Mains. By E. F. Reid, pp. 107-108.
5. Metering Water Supplies. By J. F. Haseldine, p. 109.

E — *Engineering News-Record*
9 — *July 26*
1. *c.* Driving 91 Miles of Tunnels on the Colorado River Aqueduct. By R. M. Merriman, pp. 97-105.
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2. Hetch-Hetchy Water Supply. (Special feature articles on engineering, construction and legal feature of the project), pp. 129-146.
3. Continuing Drought Cuts Water Supplies and Sets New Low Water Records, pp. 152-156.
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4. Progress in the Control of Artesian Water Supplies. By O. E. Meinzer, pp. 167-169.
5. *c.* Subaqueous Steel Pipe Line Lowered from Pipe Pontoons. By William C. Curd, pp. 170-172.
6. Water Problem Mostly Rural in Central Drought Area, pp. 181-185.
7. *n.* Surplus Earnings of Water Plants May Be Used for City Debt, p. 191.
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8. Using Government Data on Rainfall and Runoff. By C. H. Eiffert, pp. 200-201.
9. *c.* Welding a 78-in. Steel Supply Line for Seattle. By G. W. Desellem, pp. 204-205.

F — *Water Works Engineering*
9 — *July 25*
1. Helps in Handling Chlorine. By L. L. Hedgepeth, pp. 816-820.
2. City Saves $24,000 in Year Through Water Waste Survey. By Chester W. Lutz and George H. McGregor, pp. 837-838.
3. Turbid Water Caused by an Oversight in Clear Well Design. By J. Z. Columbia, pp. 838-839.
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4. A Water Works Man Abroad. (British Isles). By W. W. Brush, pp. 874, 902.
5. Tests on Under-River Mains Show Negligible Leakage. By R. L. Lawrence, p. 877.
6. Temporary Water Service Rates Charged by Los Angeles, Calif. By E. B. Mayer, p. 885.
7. Pipe Protected from Traffic Impact by Corrugated Iron Covering, p. 893.

G — *Water Works and Sewerage*
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2. Pasadena's Morris Dam Dedicated, pp. 233-234.
3. *t.* Treating Water With the Aid of Magnesium Metal. By Hermann Bach, pp. 241-243.

J — *American City*
9 — *August*
1. Improvements in the Water Utility of Orrville, O. By A. D. Webster, p. 53.

K — *Proceedings, Am. Soc. of Civil Engineers*
9 — *August*
1. *t.* Flow of Water Around Bends in Pipes. By David L. Yarnell and Floyd A. Nagler, pp. 783-797.

L — *Civil Engineering*
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1. Ware River Intake Shaft and Division Works. By Karl R. Kennison, pp. 388-392.
2. Bouquet Canyon Reservoir and Dams. By H. A. Van Norman, pp 393-397.
3. *c.* Pumping Concrete for Dam Construction. By E. W. Seemann, pp. 398-402.
4. Developing the Delaware River. By Mason J. Young, pp. 408-412.

M — *Canadian Engineer*
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1. Equipment for the Chlorination of Small Water Supplies. By Charles R. Cox, pp. 15-17.
2. Protecting Water Supplies on Common Carriers. By G. H. Ferguson, p. 18.
3. Thawing Frozen Water Mains and Service Pipes. By Reeves J. Newsom, pp. 19-22.
4. Inspection and Maintenance of Fire Hydrants. By W. H. Henby, pp. 23-24.
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5. Montreal Chlorinator Adjusts Dose to Contamination of Water. By R. E. Hayes, pp. 7-13.

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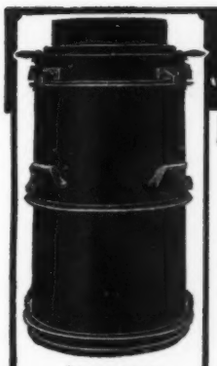
4. Diesel and Electric Pumping Costs Compared, p. 16.
5. Equipment and Methods for Thawing Frozen Mains and Services, pp. 17-18.

W — *Johnson National Drillers Journal*
9 — *June-July*
1. Development of Safe Ground Water Supplies. By O. J. Muegge, pp. 4-5.
2. Centrifugal Pumps. (Construction and Principles), pp. 12-14.

FE — *Journal, Maine Water Utilities Ass'n*
9 — *August*
1. Frost Penetration as Affected by Weather and Snow Conditions. By Harry U. Fuller, pp. 69-75.
2. Controlled and Systematic Process Employed by the Portland Water District to Eliminate Red Water. By Leavitt R. Smith, pp. 79-83.



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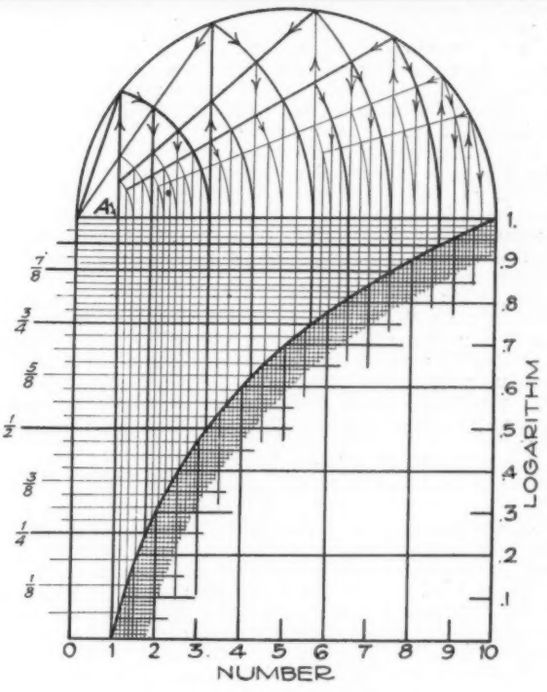

Solution to Logarithm Problem

The accompanying diagram showing the construction of table of logarithms using only a compass and straight edge is practically self explanatory. Construct a rectangle and subdivide hozizontally and vertically into ten parts and subdivide the divisions as far as desired. Superimpose a semi-circle and starting at A, one tenth the distance from the left, draw the arcs and chords as shown by the arrows. Project the points downward into the rectangle so that each point as found is half way (vertically) between the points previously found. This process can be continued indefinitely.—B. E.

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Drying and Incineration of Sewage Sludge

More comments on Mr. Stilson's article on this subject are given herewith. Others will appear in succeeding issues.

THIS article on the incineration of sewage sludge brings out many interesting points in the theory of the process and it should be the cause of added thought on the subject by those experienced in the final disposal of sewage wastes that will be of great benefit.

The ultimate result desired in the disposal of sewage sludge is to reduce it to a stable condition with the absence of objectionable odors both during the process and after it has been treated. Incineration has proved to be the best method for this final disposal.

It can be conceded that dewatering the sludge to a concentrated cake is a necessity for satisfactory incineration. Drying of this cake to a very low moisture content of course reduces to a minimum the amount of fuel needed for incineration, but it cannot be considered necessary when such cake, without such preparatory drying, has been satisfactorily consumed in properly constructed furnaces with the help of some commercial fuel, and in garbage and rubbish incinerators without the need of fuel other than the ordinary run of garbage and rubbish as delivered to the incinerator.

Complete combusion of the material is of course desirable, but most important is complete combustion of the *gases* to prevent objectionable odor, and an ash that is stable and odorless even though it might contain a slight amount of carbon.

It is pointed out that in preparatory drying of the material, after leaving the filter, to prevent odors, it should not be dried to less than 20% moisture, that the temperature should be kept between 95° and 125° F., and the drying air exhausted should pass through a zone having a temperature of over 722° F.:— and probably 1000° to 1250° F. would be better. It is further stated that, in some cases at least, the air used for drying should be from 200 to 500 times the weight of the solids to be dried.

To perform this operation of course requires considerable extra installation expense, and close regulation and careful operation to prevent odors. The quantity of heated air required greatly exceeds that required for combustion, and the heating of this air requires heat units, a considerable portion of which therefore will be lost. Also heat units must be used to maintain the hot zone for the vapors from the dryer, and power be furnished to introduce the heated air and operate the dryer.

It would be interesting to see more figures to prove, if possible, that it is more economical to add these complications and attendant installation and operating costs than to just burn the material as it comes from the filter, using if necessary a small amount of fuel to insure odorless operation. Certainly, just burning is less complicated, and it has been demonstrated that it can be done without producing objectionable odors.

The author states that it is not to be expected that one type of incinerator can closely duplicate results with all types of sludge. But if the proper principle of design is embodied in the incinerator it should, the writer claims, handle all types of sludge with the same ultimate results, except that the fuel required may vary slightly with the type of sludge burned and the furnace proportions may have to be altered slightly to meet the specific conditions.

Any incinerator should provide for unusual conditions for emergencies. It should not be designed too close to the theoretical deadline for any particular sludge, so that it can readily handle any change in the make-up of the sludge due to possible changes in the method of preliminary treatment or to change in the sewage due to heavy rain storms or the season of the year.

The heat balances used in estimating the value of paper pulp in the sludge are of course on a purely theoretical and chemical basis and do not include some slight heat losses such as radiation, heat in the ashes removed, in rushing cold air through open stoking-doors, etc. The various heat values of the relative materials are on the theoretical "ash and moisture free basis." Actually, while these heat values are possibly there from a theoretical standpoint, the ash and the moisture are present in the material being consumed and their physical presence must be overcome to fully utilize these heat units. Herein enters the design of the furnace, method of charging, the frequency and type of stoking operations, the use or absence of hot or cold forced draft, the human element and various other practical conditions. Thus in actual practice all these heat units may not help out to the extent expected in theory.

The theoretical figures shown would indicate that there are excess heat units present in 60% wet sludge over and above those needed for odorless consumption without using commercial fuel. The wet sludge used in these figures is closer to the ideal than some as to the percentage of ash and combustible present. For example, Dearborn sludge containing 67% of moisture and 21% of ash has been burned to a clean ash in an incinerator without odor. This same sludge on a 60% moisture basis would show 26% of ash and 14% of combustible. Carrying this through on a similar basis indicates a deficiency in the heat units available, so that additional commercial fuel would be needed.

In the figures shown, those regarding the advantage or disadvantage of adding paper pulp to the sludge would indicate, from a fuel value point of view, that it is not an advantage.

When taking the same Dearborn sludge, above mentioned, on a 60% wet basis and adding the same percentage of paper, it indicates that the addition of paper pulp *is* an advantage from the fuel value point of view. This shows that the individual sludge to be consumed may materially alter the conditions.

The addition of paper pulp is advantageous from the physical angle, regardless of its B.T.U. heat value, in helping to form a less dense material, making it easier to dry and get at the heat units available in the material.

Air in excess of the theoretical air is always proper, but 18 lbs. per pound of ash and moisture free combustible appears to be considerably more than would be utilized economically. It takes heat units to raise the temperature of all incoming air.

The suggestion is made that the fired material should be subjected to radiant heat in order to burn it thoroughly. The heat required for burning may come direct from the burning of the fuel added or from the material itself. The material should be placed in the furnace in such a way as to allow the most ready application of this heat to the material. Application of this heat on all sides of the material, if possible, is more important and efficient than by radiation alone from the top or sides of the mass of material being burned.

No mention is made of the use of forced draft, either heated or cold. A forced draft is of great advantage in thoroughly burning a dense material of this sort and tends to free the material from collecting ash particles. When the forced draft air is preheated by means of the waste gases of combustion it not only saves heat units, returning them to the furnace, but being heated it is rarefied and more readily absorbs moisture and enters into the chemical reactions of combustion.

In spite of the fact that my comments do not show me in full accord with Mr. Stilson's views, I want to commend him on his excellent paper. It is my hope that it will be the forerunner of other such discussions, which will be of great benefit to the final disposal of sewage sludge.

JOSEPH C. WOODMAN,
Engineer, Decarie Incinerator Corporation.

Thousands of Men at Work on a PWA Dam

More than 2,000 men, soon to be increased to 3,500, are at work at the site of Fort Peck dam, in Eastern Montana. This dam will be of earth fill, 231 ft. high above the stream bed and 3½ miles long on the crest, and will create a reservoir 175 miles long. It is designed to provide sufficient water in dry seasons to meet the navigation needs of the Missouri river for its entire length of 1,878 miles below the dam. During construction, the flow will be handled by tunnels which are well under way.

Contracts already let total $14,500,000, these including motors and machinery for dredges and booster units; 60,000 ft. of 20″ to 28″ dredge pipe line; $7,300,000 for boring and partially lining the tunnels; $1,000,000 for a power line from Great Falls, 286 miles away; two substations, and houses for employees. Already a railroad 12½ mi. long, a highway 18 mi. long, and a steel bridge have been completed. The total allotment of PWA funds for the work is $25,000,000.

Mr. T. S. Boyle Mayor of Whiting, Indiana

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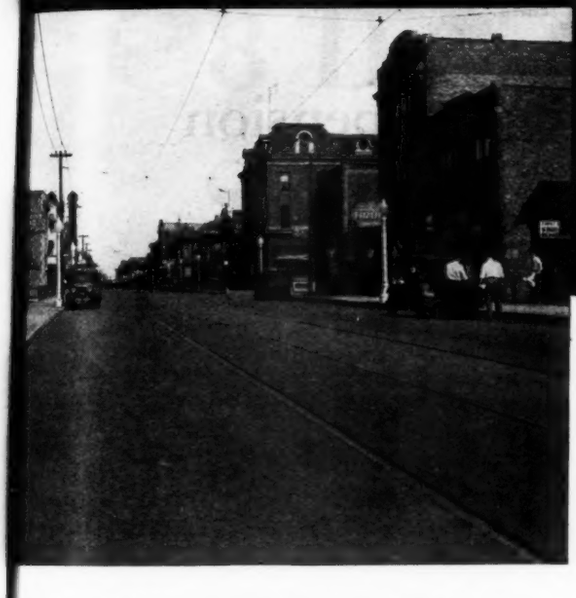

THIS broad, smooth expanse of asphalt through the heart of Whiting, Indiana, is more than a source of pride, however, to local merchants. They say that it is also a substantial trade-producer—inviting business not only from the surrounding area but also from the steady stream of motorists who traverse it on their way in and out of Chicago over U. S. Highways No. 12 and No. 20. To these travelers it gives a favorable impression of this modern, progressive city.

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Standard Oil Company (Indiana) engineers will welcome the opportunity to make honest, careful recommendations to those interested in paving and highway programs. They are equipped to advise the correct type of materials and methods for the particular job. Please feel free to ask for this service. No obligation is involved.

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"We have had fewer auto accidents since the completion of street. Good traction of street surface could be credited for improved traffic conditions."
Clay C. Collins, Chief of Police

"Traffic, of course, has greatly increased since this pavement was put in. Our business has improved too."
Jennings-Mattern Pharmacy, R. A. Fischer, Mgr.

"It is much more quiet than other types of pavement. We know, too, that this street can be repaired more easily and cheaply. If bad spots develop they can be quickly repaired for very few dollars."
H. Gordon & Sons, Dept. Store, R. F. Gordon, Mgr.

"The number of people shopping on this street has considerably increased since this new pavement was installed."
O'Keefe's Cafe, J. O'Keefe

"I don't think the city ever got more for its money than in this job. Our business is now the best in four years and I think this street has helped us to make this record. The street presents a fine appearance, invites traffic, is unusually smooth and resilient to drive upon. Its dark color, I believe, is restful to the eyes."
Winsberg's Men's Wear, Abe Winsberg, Mgr.

"We have heard a great many enthusiastic compliments since the pavement was installed. We note, too, an increased pride among the merchants and business men of this district in the appearance of their stores and methods of inviting business."
W. E. Schrage, President, Bank of Whiting

STANDARD OIL COMPANY
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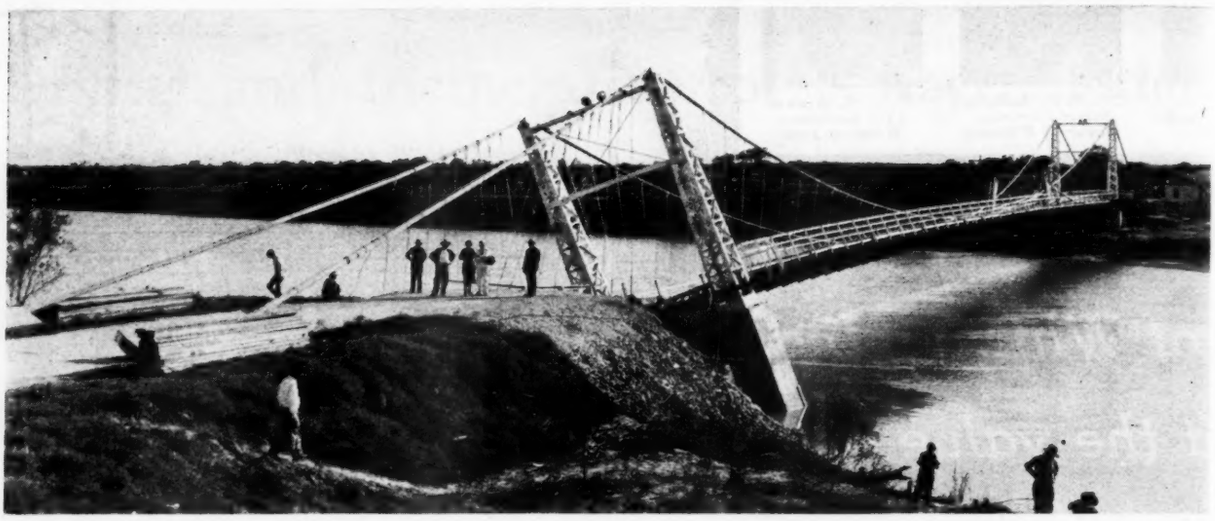


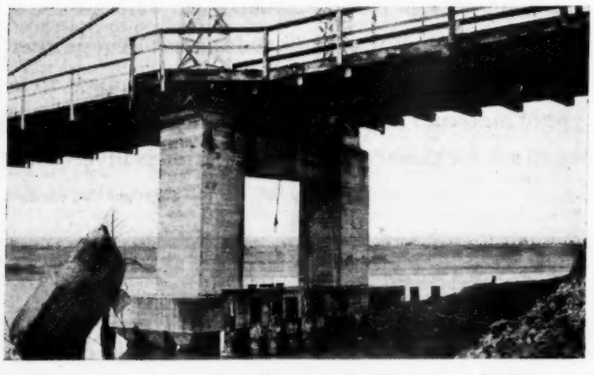
Hidalgo-Reynosa bridge after the pier settled.

Rapid Work in Restoring Suspension Bridge Towers

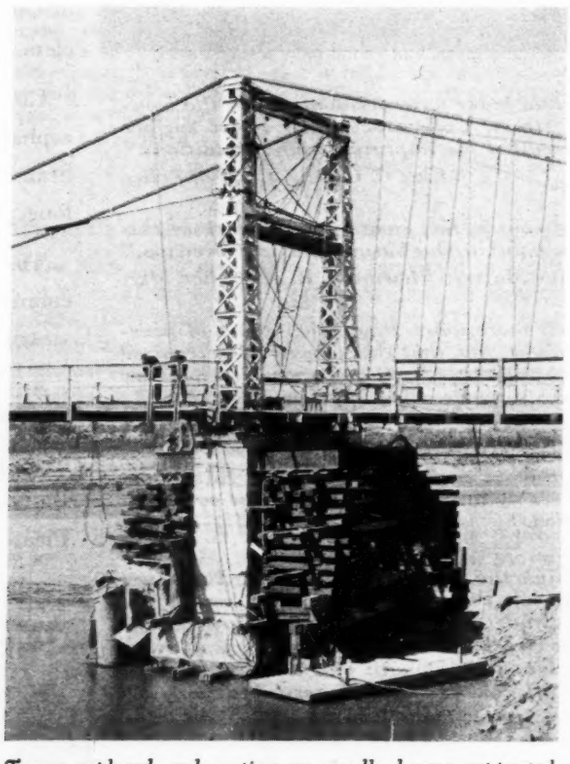
"TIME is money" is true of many situations; although it may seldom be possible to estimate the exact value. The time that a street or highway is kept closed to traffic for repairs or repairing is an illustration involving loss of business to merchants or cost of traveling detours to would-be users of the road.

An unusual case occurred last November at Hidalgo, Texas. A suspension toll bridge crosses the Rio Grande between this city and Reynosa, Mexico, connecting Texas State Highway No. 66 with the Mexican highway to Monteney, and there is no other highway bridge across the river for 55 miles up stream and 30 miles down. Floods during September had deepened the channel close to the American pier of this bridge, but it was not realized that the pier foundation had been seriously weakened until, about 1 P. M. November 3rd, it suddenly failed. The pier and tower tipped down stream and the base moved toward midstream, but the anchored cables held it more or less upright, and it remained standing approximately 22° out of plumb. The structure of the roadway proper was of course distorted; but it appeared that if a giant hand could have lifted the pier and its tower back to position and put a new foundation under it, the bridge would be as good as new after straightening a few minor parts and replacing a few bottom diagonal braces in the roadway which had parted.

(Continued on page 40)



Reconstruction completed—part of old pier at the left.

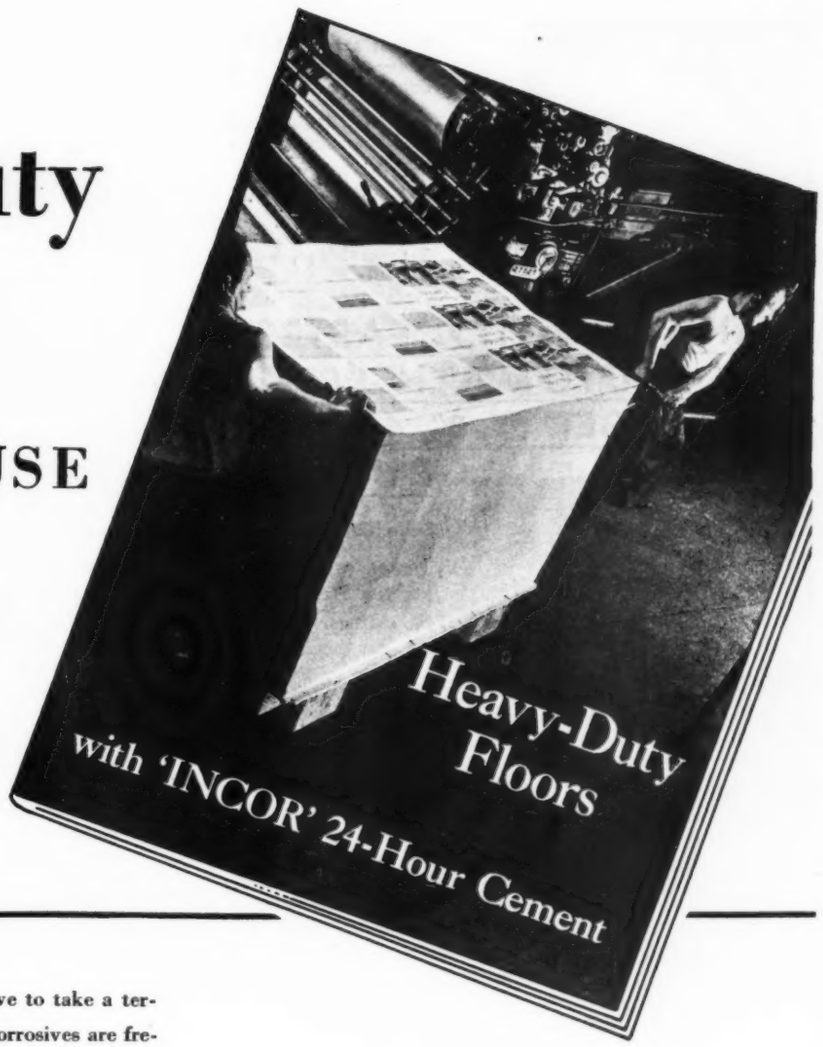


Tower replaced and resting on needle beams supported by cribbing.

Heavy-Duty Floors

READY FOR USE

8 Days Sooner



Most industrial floors have to take a terrific 'beating.' Steel-tired trucks, acids and corrosives are frequently encountered. So, in addition to adequate strength, a heavy-duty concrete floor also has to have exceptional durability. That means good materials and skilled workmanship—and, above all, adequate curing.

Thorough curing, using ordinary Portland cement, requires 10 days under water. But floors have to be used sooner than that; so it often happens that concrete isn't adequately cured.

Service-strong in 24 hours, an 'Incor' floor cures as thoroughly in 48 hours as ordinary Portland cement in 10 days—because 'Incor' combines with water five times as fast. By making it so much easier to obtain thoroughly cured concrete, 'Incor' Cement in the hands of skilled workmen is the soundest assurance of durable heavy-duty floors.

Illustrated above is new book containing a clear-cut outline of successful floor-topping methods. A copy will be sent free, on request. Send convenient coupon below. 'Incor'* is made and sold by producers of Lone Star Cement, subsidiaries of International Cement Corporation, New York; also sold by other leading cement manufacturers.

*REG. U. S. PAT. OFF.

HEAVY-DUTY FLOOR CONSTRUCTION

Presented in non-technical language—all essential points illustrated with pictures specially taken for this purpose.

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Please send me free copy of illustrated book, "Heavy-Duty Floors" P. W.

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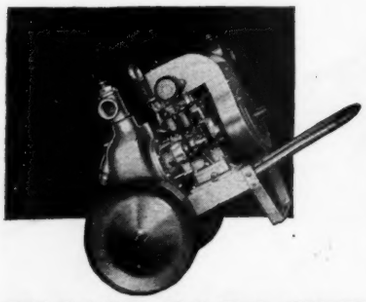


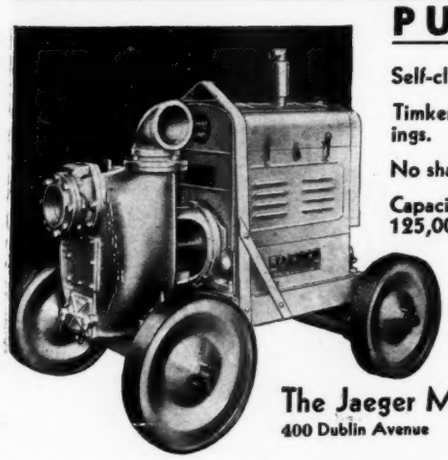
Primes at over 25 ft. lifts—without hand adjustment.

No hand adjustment for recirculation cut-off.

Compact, rugged — one moving part.

3 times bigger water passages.

GIANT CAPACITY, FASTEST 100% AUTOMATIC PRIME with JAEGER 2", 3", 4", 6", 8", PUMPS!



Self-cleaning shell.

Timken or ball bearings.

No shaft packing.

Capacities 10,000 to 125,000 g.p.h.

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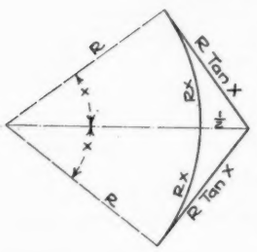


R = radius of earth in feet
x = angle in radians.
L = lengthening of wire
= 2R tan x - 2Rx

$\cos x = 1 - \frac{x^2}{2} + \frac{x^4}{4} - \frac{x^6}{6} + \cdots$

For small angles,
$\cos x = 1 - \frac{x^2}{2}$ with negligible error

$\sec x = 1 + \frac{x^2}{2}$ very nearly

$R \sec x - \frac{1}{2} = R$

$R\left(1 - \frac{x^2}{2}\right) - \frac{1}{2} = R$

$x = \sqrt{\frac{1}{R}}$

$\tan x = x + \frac{x^3}{3} + \frac{2x^5}{15} + \cdots$

For small angles, $\tan x = x + \frac{x^3}{3}$ - very nearly

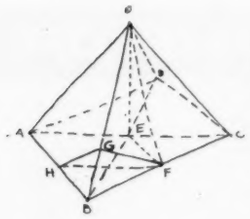
$L = 2R \tan x - 2Rx = 2R\left(x + \frac{x^3}{3}\right) - 2Rx$

$L = \frac{1}{3} Rx^3 = \frac{1}{3} R\left(\frac{1}{R}\sqrt{\frac{1}{R}}\right) = \frac{1}{3}\sqrt{\frac{1}{R}}$

$R = 21{,}120{,}000$ feet $L = \frac{1}{4000}$ foot $= \frac{1}{110}$ inch. BE

See July issue of PUBLIC WORKS.

THE PYRAMID



ϕ = angle of slope of face = 45°

AB = BC = CD = DA = length of edge = 1

Draw EF ⊥ to BC. $EF = \frac{1}{2}$ OE

$OF = \sqrt{\frac{1}{4} + \frac{1}{4}} = \sqrt{\frac{1}{2}}$ $BF = \frac{1}{2}$

$OB = \sqrt{\frac{1}{2} + \frac{1}{4}} = \sqrt{\frac{3}{4}}$

Draw FG ⊥ to OB $\frac{FG}{BF} = \frac{OF}{OB}$

$FG = \frac{BF \times OF}{OB} = \frac{\frac{1}{2} \times \sqrt{\frac{1}{2}}}{\sqrt{\frac{3}{4}}} = \frac{\sqrt{2}}{6}$

$BG = \sqrt{\frac{1}{2} - \frac{1}{6}} = \frac{\sqrt{3}}{3}$

Draw GH ⊥ to OB $HB = BF = \frac{1}{2}$ $GH = GF = \frac{\sqrt{2}}{6}$ $HF = \sqrt{\frac{1}{2} + \frac{1}{2}} = \frac{\sqrt{2}}{2}$

The angle HGF is twice the required angle of bevel

Solving: $\frac{1}{2} = \frac{1}{3} + \frac{1}{3}\cos HGF$; $3 = 2 + 2\cos HGF$ See August

$\cos HGF = \frac{1}{2}$ $HGF = 60°$. Bevel angle = 30° PUBLIC WORKS

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(Continued from page 38)

The serious interference with international traffic called for the promptest possible action, as did also the danger that further and more disastrous settlement of the pier might take place. Contractors consulted agreed that the uncertainty of condition of the foundation, the probability that the plan of repair would need to be adjusted from day to day, and the hazard involved made day-labor work advisable, and the owners of the bridge employed the J. W. Beretta Engineers, Inc., of San Antonio, to organize the work, lease the necessary equipment and purchase materials. Actual reconstruction began November 13th.

The plans adopted and carried out comprised driving precast concrete piles 50 ft. long as a foundation, lifting the tower into position, and constructing new concrete pile cap and corbels on the new piles.

To lift the tower, temporary piling was driven, a timber cribbing built on this, needle beams inserted and interfering parts of the old pier cut away. The tower was braced, blocked and lashed so that both tower legs could be handled as a unit. After insertion of needle beams and bolting to the tower legs, the towers were moved to new position by the use of 75-ton hydraulic jacks, steamboat ratchets and turn-buckles. When they were approximately in their proper position but still below grade, the cribbing was rearranged to permit pouring the pile cap and corbels on top of the new piles.

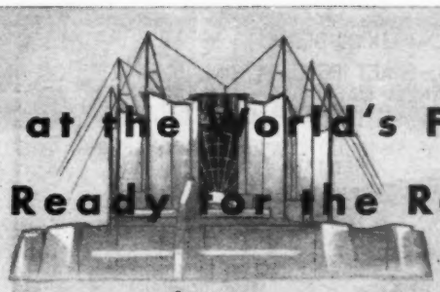
The concrete foundation piles had to be made, and it was evident that their early completion and use was a vital feature of the rapid repair. High-early-strength cement was used in constructing them, and driving began within five days of the pouring of the first pile. The concrete was mixed 1 part "Incor" cement, 1½ sand, 3 coarse aggregate; 4½ gal. water per sack; slump, 4 in. The piles were 16" x 18" x 50' and weighed 7½ tons each. They were driven through 10 ft. of loose rock, river silt to 30 ft., 2 ft. of hard material, then river silt, with an average of 60 blows per inch with a vulcan steam hammer. After driving ceased, pile heads were still in excellent condition.

In constructing the pile cap, the lower portion was formed with ordinary cement, but high-early-strength was used for the top two feet; the whole cap being placed with a continuous pour, with no construction joint between the two kinds of concrete. Three or four winter months after it was poured nothing but a slight difference in color indicated where the two kinds met. Within 48 hours after the pier cap was poured, jacking operations began.

The tower was jacked into correct position, plumb and true, and securely anchor bolted. At the end of 21 days the cribbing was removed, the needle beams burned off flush with the new concrete pier, and the remaining portions of the old pier pushed over into the river bed.

The last workman left the job on February 28th, but the bridge was opened for limited traffic at low speed on December 20th. (It is estimated that the use of high-early-strength cement advanced this date by as much as six weeks.) Following that date, traffic was delayed only intermittently at various times.

The total cost of the work was slightly less than $16,000, including all labor, materials, equipment, insurance and engineering. The superintendent of erection was D. R. Parsons. The resident engineer and supervisor, representing the J. W. Beretta Engineers, Inc., was H. F. Stubbs, to whom is due great credit for the development of erection methods and the satisfactory handling of a difficult project.



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Now Ready for the Road:

A new and greater line of

INTERNATIONAL TRUCKS

Latest and finest of trucks . . . A new high in style and distinction . . . New values in utility and performance . . . *A complete new line of Internationals!* The powerful unit shown below is one of a beautifully streamlined series of trucks that are *all-truck*, embodying new engineering features and new mechanical excellence throughout. Take Harvester's word for it—the quality apparent on the surface is more than matched by the quality underneath. It is the *EXTRA quality* that International Truck owners have banked on for *more than thirty years*. See these new Internationals. All models, from ½-ton up, now on display at International branches and dealers. For details, write the address below.

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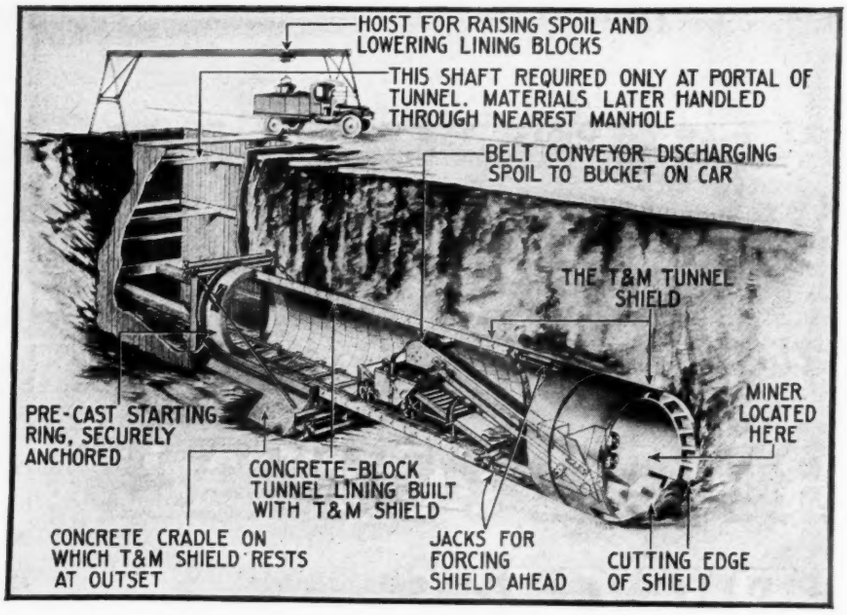

HOIST FOR RAISING SPOIL AND LOWERING LINING BLOCKS
THIS SHAFT REQUIRED ONLY AT PORTAL OF TUNNEL. MATERIALS LATER HANDLED THROUGH NEAREST MANHOLE
BELT CONVEYOR DISCHARGING SPOIL TO BUCKET ON CAR
THE T&M TUNNEL SHIELD
MINER LOCATED HERE
PRE-CAST STARTING RING, SECURELY ANCHORED
CONCRETE-BLOCK TUNNEL LINING BUILT WITH T&M SHIELD
CONCRETE CRADLE ON WHICH T&M SHIELD RESTS AT OUTSET
JACKS FOR FORCING SHIELD AHEAD
CUTTING EDGE OF SHIELD

This illustration shows a cutaway view of the shield at work, with the shaft at the left, the cutting face, the conveyor and industrial car, and the tunnel lining

Tunneling for Sewers and Other Utilities

SEWERS must be built to a predetermined grade, and deep cuts or tunnels are sometimes necessary; and sewers, water pipes or utility conduits often must be carried under railroads, streets, bridge abutments or other places where open cut construction would be difficult or very costly. Jacking a pipe through (which method has been described in several articles in PUBLIC WORKS) or tunneling may be much cheaper or easier.

It is not generally desirable or economical to construct a tunnel of less than about 4 feet diameter, even though the pipe to be carried through it is considerably smaller than this. The cost for a smaller tunnel might be as great or greater, since the constricted space interferes with the workmen, and it is difficult to timber or support a small tunnel, and still leave room to carry on the work.

There are relatively few cases where the earth is firm enough to stand without support; and this is practically never the case when tunneling under railroads or streets due to the vibration of trains or vehicles. In wet or running soils, troubles are magnified greatly; not only must the roof and walls be properly supported, but a shield must be carried forward at the face of the tunnel.

Recent developments in tunnel equipment have simplified and cheapened tunnel construction. Typical of these more modern developments is the T & M type shield, produced by the Link Belt Co., which is shown in Fig. 1, and which has been used on several recent jobs, as described below.

This shield consists of an adjustable hood and cutting edge, the shield proper, jacks for forcing it into the face of the tunnel, and a belt conveyor for the removal of the excavated material. As the shield is forced ahead by the jacks, the tunnel is lined behind the shield with precast concrete blocks of a special design, interlocking on all contiguous surfaces, and having the joints filled with heavy asphalt before the blocks are placed. The tube thus formed is rigid and watertight, and there is no settling or ground subsidence, which is a factor of much importance when working under railroad tracks or paved streets.

Lansdowne Sewer Tunnel

Some time ago, the borough of Lansdowne, Pa., was faced with the necessity of increasing the capacity of certain of its storm-water sewers. A survey disclosed that at one point a 4-foot conduit was necessary which would pass under the tracks of the Pennsylvania Railroad about 100 feet east of the Lansdowne railroad station and just at the end of the station platform.

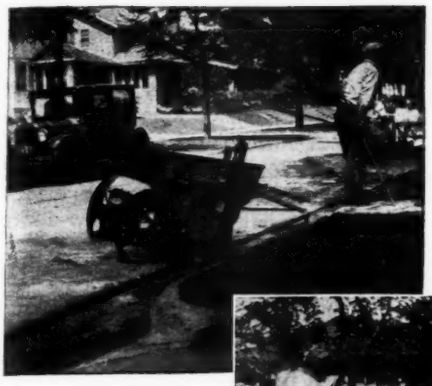
At this point there had been built at one time a series of coal pockets, with a 3-foot rough-stone retaining wall against the railroad right-of-way. These pockets had since been converted into garages with concrete floors. Immediately opposite on the other side of the tracks was a yard used for the storage of cast iron pipe and enclosed with a 6-foot wire fence. The railroad right-of-way, about 50 feet wide and used by both steam and electric trains, was subject to heavy suburban traffic.

The Pennsylvania Railroad did not consider it safe to shore the tracks at this point so that an open cut could be made for the installation of sewer pipe. This, with the other physical conditions mentioned above, made it evident that some other method of working must be considered. Finally it was decided to tunnel by use of a shield, which proposal met with the approval of the railroad engineers.

Instead of advertising for bids and having the work done by contract, the tunnel shield and the block-making equipment were obtained from the manufacturers on a royalty basis, together with two experienced machine operators and a foreman, who were placed on the borough payroll. The remainder of the labor was supplied from the regular borough labor gang, as only seven men were required, including the operator and foreman, for this machine. The concrete blocks were made near the site of the tunnel, in the borough storage yard.

During the progress of the tunnel work, two 3-foot-thick stone wall footings were encountered instead of the one known to exist, but these were successfully removed through the machine, and a 61-foot tunnel was completed under the tracks. The advantages gained by the method adopted were the speed with which the work was undertaken and completed, the low cost to the borough, and the avoidance of all delay to trains and to the commuting citizens of Lansdowne.

MUD-JACK METHOD



The No. 10 N. E. C. Mud-Jack raising depressed curb and gutter.

Sunken sidewalk slad raised to correct grade —No construction expense—No obstructions on street or walk.

Saves the Curb, Gutter and Sidewalk

The Mud-Jack method of raising concrete curb, gutter, walks, and streets has solved the problem of reclaiming and correcting sunken concrete slab. It is the modern method to increase the life of concrete. Curb, gutter, walks and streets can be raised to original grade. All of this without reconstruction — the saving accomplished pays for the machine in less than one season's operation — in addition to the protection of the original investment.

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Milwaukee Wisconsin

For Raising Concrete Curb, Gutter, Walks, Street

Theo. De Witt Says—

After
OCTOBER 1st

In TOLEDO It's
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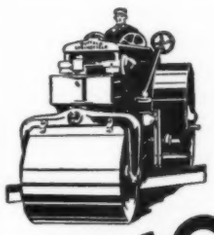
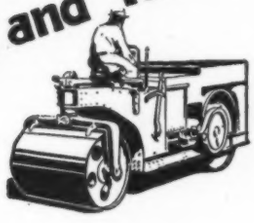
Coffee Shop
AND
Parisian Cocktail Bar

RATES FROM
$2.50 Single *$4.00 Double*



BUFFALO-SPRINGFIELD
Three Wheel and Tandem



Buffalo-Springfield's complete range of models in both three-wheel and tandem rollers permits the purchaser to select the proper machines for his work.

Full details will be furnished on request.

THE BUFFALO-SPRINGFIELD ROLLER CO.
SPRINGFIELD, OHIO

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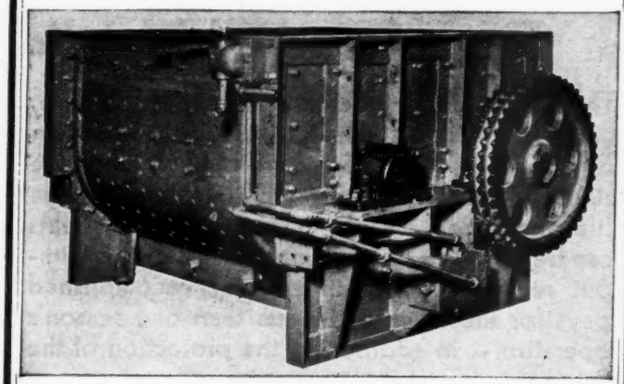
STEAM OPERATED ASPHALT
MIXERS
For Bituminous Mixtures of All Kinds



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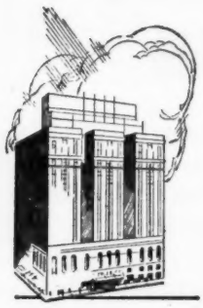
Send for Bulletin M-234
HETHERINGTON & BERNER, Inc.
INDIANAPOLIS, IND.
Builders Of Asphalt Paving Machinery For 30 Years

...HAVE YOU HEARD *the one about the traveling salesman?*

He went to bed at the William Penn and slept twenty years! Well, maybe that is a little exaggerated. But anyway, the beds at Pittsburgh's number one hotel are so comfortable you don't ever want to get up. The food in the four famous restaurants is equally exceptional, and the prices reasonable. Quiet, well-furnished rooms, $3.50 single; $5.00 double, all with bath.



1600 ROOMS . 1600 BATHS
HOTEL WILLIAM PENN
PITTSBURGH, PENNA.

When writing, we will appreciate your mentioning PUBLIC WORKS.

Other Small Tunnel Jobs

On another job, an electrical conduit tunnel 4′ in diameter and 100′ long was driven with this type of tunnel shield and lined with pre-cast concrete blocks, for the Philadelphia Electric Company, under a busy 4-track main line of the Pennsylvania Railroad in North Philadelphia. Although the bore had but 5 feet of cover, rail traffic overhead was not disturbed or slowed down during construction operations. A progress of 20 ft. per day (10-hour shift) was made through a hard, sandy clay material containing a considerable number of small boulders. The block lining thickness is 5″. At another location in Philadelphia a 4′ concrete block-lined tunnel under fifteen Reading Company tracks was built in two weeks, without danger or slow-down orders, and at minimum expense.

Generally speaking, shields of this type are shipped completely assembled for the construction of tunnels 4′-0″ to 8′-0″ inside diameter. When a tunnel larger than 8′-0″ is required, the shield is shipped to the site in sections, and assembled in the shaft.

How the Shield Works

A shaft is sunk on line and to a point below the grade of the required sewer. A concrete cradle is then constructed in the bottom of this shaft to coincide with the outside diameter of the shield, and to exact line and grade of the under side of lining. The shield is lowered on to this cradle. A pre-cast starting ring is then set in the cradle, in contact with the rear of the shield, and securely anchored in position.

There are 16 to 24 hydraulic jacks located equi-distant around the rear inside perimeter of the shield, the number of jacks corresponding to the number of pre-cast concrete blocks required to make a complete circle of tunnel lining. The action of the jacks against each ring of the lining blocks forces the shield ahead and into the earth at the heading.

The dirt is mined off by a workman in the head of the machine, and scraped onto the foot end of the small belt conveyor, which carries the dirt back and dumps it into a spoil car running on a narrow-gauge track in the bottom of the completed tunnel. The car carries the spoil back to the nearest manhole, where it is hoisted to the street level and dumped into trucks for disposal. On the return trip of the car, blocks for lining the tunnel are carried into the shield.

The guiding of the shield accurately to line and grade through the ground is accomplished by the articulation of the front half of the shield in relation to the rear half.

Application

This type of tunnel shield is not designed for tunneling through hard rock; however, boulders and isolated sections of ledge rock, when encountered, have been successfully and economically disposed of through the use of drills and dynamite.

The tunnel is driven without interfering with traffic. The only place where the surface of the street is disturbed is at the starting shaft, and the small excavations for standard manholes at required intervals.

The concrete block lining, when laid up in the shield, practically fits the bore produced by the cutting edges; consequently, there is no danger of settlement of the earth above the tunnel, which in turn eliminates the danger of building or water pipe settlement in the street. This is evidenced by the fact that a number of such tunnels have been constructed by this method under the main lines of the Pennsylvania Railroad, just under the ties, and it has not been necessary to re-surface the tracks or issue "slow" orders.

News of the Engineers

Thorndike Saville, Professor of Hydraulic and Sanitary Engineering, New York University, has been appointed by Secretary Ickes as executive engineer in immediate charge of the administration's water resources inquiry. The investigations are being made by the National Resources Board to formulate a plan for the development of the nation's water resources.

M. B. Tark, engineer of the Link-Belt Co., has returned from a European trip in which he viewed a number of new developments in water and sewage engineering.

G. A. Draper has resigned as chief engineer of the Mississippi Highway Department to become Supervisor of Research. R. A. Harris, assistant construction engineer of the Department, has been appointed to succeed Mr. Draper.

Andrew D. Hunt has been appointed manager of engineering of the So. Philadelphia Works of the Westinghouse Electric & Mfg. Co.

Ralph C. Harden has been appointed manager of the packing sales division, U. S. Rubber Co., with headquarters in New York.

Pennsylvania Water Works Association:

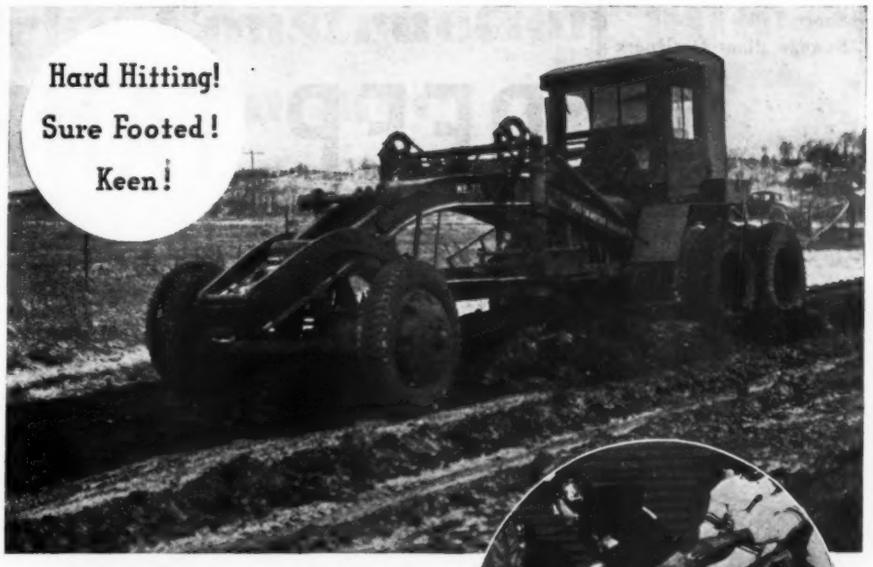
The following officers have been elected by the Pennsylvania Water Works Association: President, H. M. Freeburn, Philadelphia; Vice-presidents, C. L. Fox, Wilkinsburg and C. W. Kunkle, Johnstown; Secretary-treasurer, I. M. Glace, State Board of Health, Harrisburg.

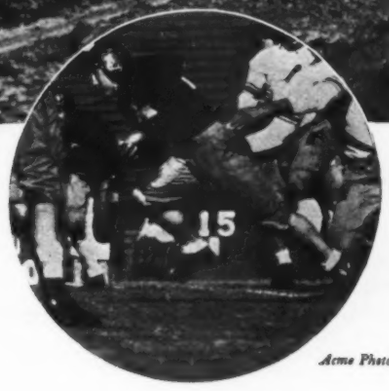
American Waterworks Association, Wisconsin Section:

The Thirtenth Annual Meeting of the Wisconsin Section of the American Waterworks Association has definitely been scheduled for Sptember 24th, 25th and 26th, at Wausau, Wisconsin—the actual meetings to be held on September 25th and 26th.

New England Water Works Association:

Howard M. King has been nominated for the presidency of the New England Water Works Association. Mr. King is superintendent of the Springfield, Mass., water Department. Harry U. Fuller, chief engineer of the Portland Water District, Portland, Me., has been nominated for the Vice Presidency. Percy A. Shaw, superintendent of the Manchester, N. H., water works, has been nominated for director, and Leland G. Carlton, Water Register of Springfield, Mass., for treasurer.





Acme Photo

THE GROUND GAINERS go through!

● To gain ground against any resistance is the winning quality—in road machinery as in football. Highway contractors and maintenance men have discovered that "Austin 77" is the signal to go over the goal line.

The 77's dual traction, held to the road by sufficient weight and backed up by a full-powered 6-cylinder motor (oil-burning optional) puts the blade "through." And, there's no flinching at the blade; the wide front axle with leaning wheels equalizes the load.

The range of work to which the "Austin 77's" six-speed transmission can be applied with fully satisfying results is enormous. Its versatility (for oil mix, snow removal, grading, ditching, scarifying, etc.) helps it to pay for itself six times as fast as any single purpose machine. Send coupon.

Oil mix—only one of the 6 types of work for which the "Austin 77" is made.

The Austin-Western Road Machinery Co.
Home Office: Aurora, Ill.
Cable Address: AWCO, Aurora
Branches in Principal Cities

Austin-Western

ROAD ROLLERS CRUSHING & SCREENING PLANTS SCARIFIERS SWEEPERS & SPRINKLERS ROAD GRADERS ELEVATING GRADERS MOTOR GRADERS DRAGS ... DISTRIBUTORS WAGONS SNOW PLOWS

The Austin-Western Road Machinery Co.
A-5 Aurora, Illinois
Please send me details about "Austin 77."
Name.....
Firm.....
Address.....
City..... State.....

Material Prices

(Published for information only.)

(August 23, 1934)

Warehouse Prices on Reinforcing Steel and Structural Shapes

	Structural Shapes	*New Billet Reinforcing Bars*
New York	3.37c	—
Boston	3.42	—
St. Louis	3.44	—
Cincinnati	3.40	3.25
Pittsburgh	3.15	2.90
Chicago	3.20	—
Philadelphia	2.95	2.955
Cleveland	3.31	2.10*
San Francisco	3.55	3.50

**Plus extras*

Prices on cast iron pipe, net per ton, Class B, 6-inch and larger, AWWA specifications*

Boston	$47.50	Baltimore	$45.50
New York	44.90	Atlanta	42.00
Chicago	46.00	Birmingham	38.00
Minneapolis	48.50	Kansas City	48.15

Burlington, N. J., $42.00; extra price for 4-inch, $3.00 per ton; extra for Class A, $3.00 per ton.

**Information, courtesy U. S. Pipe & Foundry Co.*

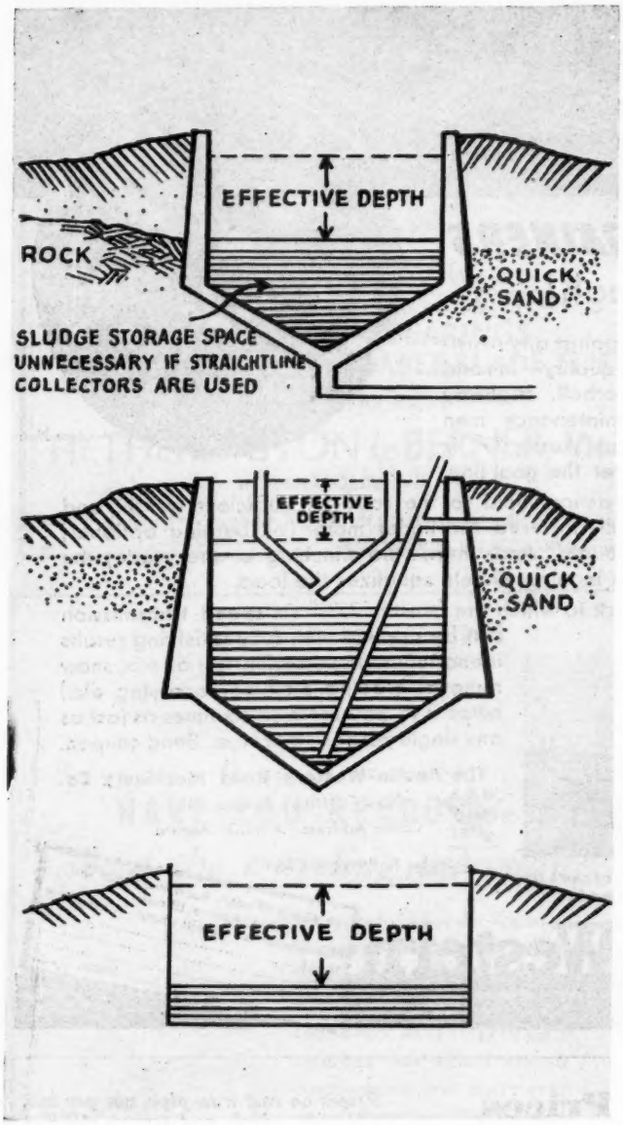
Warehouse Prices on American Pig Lead

Per pound

New York	4.50 to 5.50
Cleveland	4.75 to 5.00

Short Talks With Sewage Plant Designers

DEEP TANKS *are expensive*



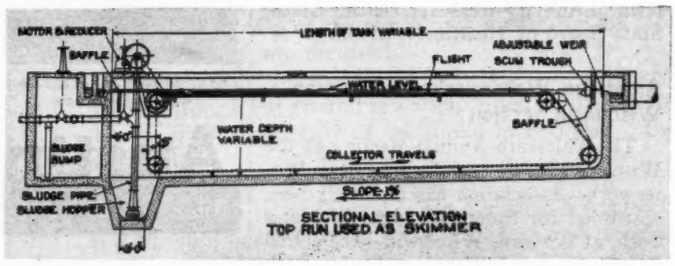
A TANK fifteen feet deep may cost five times as much as one eight feet deep, especially if rock or quicksand is encountered.

Why pay for sludge storage space in deep tanks?

Depth is a serious disadvantage of the two-story Imhoff tank. It is not so generally recognized that this objection applies to *any* tank from which the sludge is not removed at least once a day. The effective depth of a sedimentation tank extends only to the top of the sludge when the accumulation is deepest. From this level down, is simply sludge storage space, and a more expensive place to put it could not be found. If the tank bottom consists of a series of hoppers for drawing off the sludge, the additional 4 to 8 ft. depth of these, adds greatly to the cost.

The cheapest tank to construct is one 8 or 10 ft. deep, with a flat bottom and straight sides; and, given the right proportional width and length, and good influent distribution, it is also the most effective, if the sludge is removed regularly and not allowed to accumulate anywhere to an appreciable depth.

Regular, complete removal of sludge from rectangular flat-bottom tanks, is performed efficiently by the Straightline Collector, which for more than twelve years has given satisfaction in scores of plants.



Straightline Collector as used in Primary Tank where top run serves also as a scum collector.

LINK-BELT COMPANY

PHILADELPHIA, 2045 West Hunting Park Avenue — CHICAGO, 300 West Pershing Road
SAN FRANCISCO, 400 Paul Ave. — TORONTO, Eastern Ave. & Leslie St. — Offices in Principal Cities

4921

LINK-BELT

SCREENS ▲ COLLECTORS ▲ AERATORS ▲ GRIT CHAMBERS ▲ DISTRIBUTORS

See Our Exhibit at A Century of Progress, General Exhibits Building No. 1

When you need catalogs—consult the *classified* READERS' SERVICE DEPT., pages 51-53.

Waterworks Construction and Maintenance

Flexlock Rubber Joints for Pipe:

The Flexlock Rubber Joint is a flexible, boltless, mechanical joint which is absolutely tight at high pressures. It is adaptable to all kinds of bell and spigot pipe as well as to straight end pipe.

The Flexlock water and sewer joint.

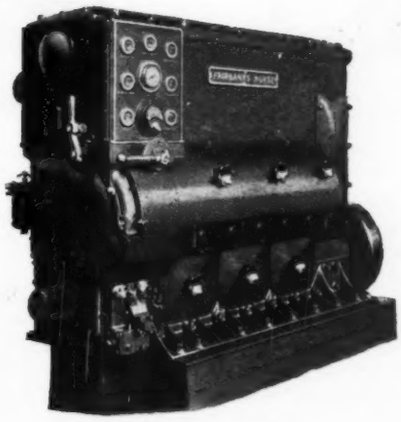
Flexlock Rubber Joints for bell and spigot cast iron pipe and for sewer pipe are now available in several sizes. Other sizes will be ready in the near future.

Literature describing the several types of joints is being prepared. To receive this literature, write to The Atlas Mineral Products Company, Mertztown, Pennsylvania.

Fairbanks-Morse Opposed Piston Diesel Engine:

The weight of this new F-M diesel is 20-lb. per hp.; at the same time improved scavenging and a greater virtual stroke-bore ratio has resulted in improved combustion efficiency. The construction has been simplified by a substantial reduction in the number of parts.

While these engines are designed primarily for installations where weight and space are an important factor such as for marine and mobile equipment they are equally adaptable for stationary work. Because of their light weight and compact construction these engines are suited to mobile industrial equipment such as dredges, draglines and excavators.



F-M Opposed Diesel Engine.

Engines of the opposed piston type are inherently balanced because the reaction forces of the two pistons in the cylinder oppose and tend to counteract each other. This leads to higher rotative and piston speeds with a consequent reduction in weight.

These engines are available in five cylinder sizes, 5 by 6 in., 6½ by 8, 8 by 10, 10 by 12 and 12 by 15 in. and in 6, 7 and 8 cylinder combinations with a 5 cylinder size in the smallest bore. Power capacities range from 50 to 300 hp. per cylinder, or for the engine, from 250 to 2400 hp.

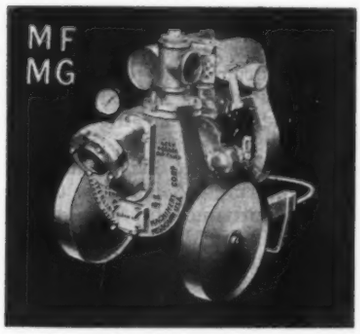
Utilizing the Power of Your Truck:

A power take off for the motor truck has been developed by the Ditwiler Mfg. Co. of Galion, O. A standard unit has been developed for highway and general utility work which includes a 140-foot air compressor with tank, a 300-amp. Arc Welder, and a self-priming centrifugal water pump. Other units can be added or substituted. The equipment can be mounted in a standard or specially designed body, on a medium sized truck, with room remaining for five men. Such a portable unit of power driven equipment is of almost constant use in every city, county or state highway or public works department.

Truck with pump, welder and air compressor.

Self-Priming Centrifugal Pump:

A radical improvement in self-priming centrifugal pumps, providing quick priming and controlling recirculation without the use of valves, has been announced by Sterling Machinery Corp., 411-13 Southwest Blvd., Kansas City, Mo., in its new line of 2, 2½, 3, 4 and 6-inch centrifugal pumps. A removable check valve independent of the automatic priming device is built into the suction connection to hold the prime in suction line. A vacuum gage for checking the suction lift and priming action are standard equipment. A bail for lowering into excavations and an improved steel strainer are also provided.



The Sterling Pump.

No valves are used in the discharge line to control recirculation of the water after the pump is primed. The elimination of this valve to control recirculation has been taken care of by the use of the centrifugal force of the water revolving in the outer chamber of the pump.

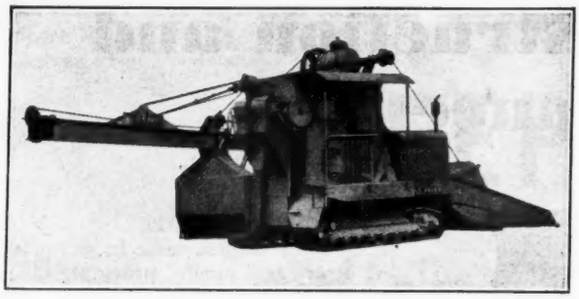
All suction and discharge connections are fitted with flanges making it easy to connect and disconnect the suction and discharge hoses or pipes. These units are especially well adapted for pumping out manholes, excavations, trenches, etc., and for irrigating service.

Blue Printing Equipment:

The new No. 11 Pease blue-printing machine will produce 12 feet of blueprints per minute, at lowest cost. It consists of three units—a blue-printing machine, a washing unit, and a potashing and drying unit. The blue-printing machine can be operated independently from the others. The standard model takes paper up to 42 inches wide; special models print up to 54 inches. Operation is by a ¼ hp motor. It is manufactured by the C. F. Pease Co., 813-821 No. Franklin St., Chicago, Ill.

Dewatering Pumps:

Jaeger "Sure-Prime" pumps are described in Bulletin P 34, issued by Jaeger Machine Co., Columbus, O.



The New Rex Highway Paver

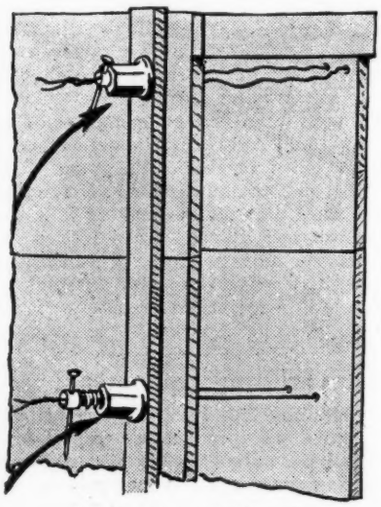
A New Rex Highway Paver:

The outstanding feature of the newest Rex paver is its modern high carbon steel drum with replaceable alloy steel liners on each of its buckets and blades, and in its charging head. Rubber sealing rings prevent leakage with low slump concrete. This drum runs on Timken bearings. Aside from the drum the next outstanding features are the Rex Mechanical Man and the Governor Booster which work together to make for faster charge and discharge.

This new paver is more fully described in Bulletin No. 244, issued by Chain Belt Co., Milwaukee, Wisc., which will be sent on request.

Helps on Form Work:

A new form tightener has been introduced for use with wire ties, which eliminates the twisting of wire under tension and makes it unnecessary for workmen to reach or climb into forms to twist ties for adjustments. It is thus particularly well

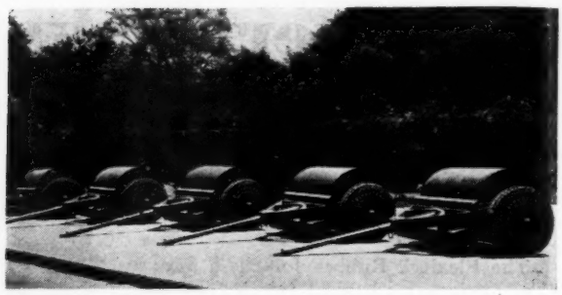


Marion Form Tightener

adapted for centering on thin wall sections.

The operation is simple. The two ends of the wire tie are brought through the formwork in the usual manner and passed through the tightener. A nail is inserted through a hole in the tightener screw, passing between the two ends of the tie. The wires are given a couple of turns, as at A, and then the workman, holding the nail with one hand, uses a wrench on the nut, making the wires taut and drawing the forms together to the ultimate strength of the wire, as shown at B.

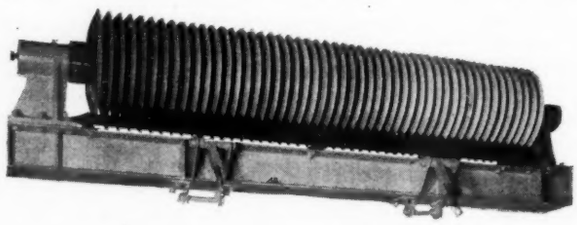
The use of this device, made by the Marion Malleable Iron Works, Marion, Indiana, is said to make accurate alignment of forms easy and economical. The tighteners, which are reclaimable, are made of certified malleable iron and are practically indestructible.



Roller Becomes Trailer—Something new in roadmaking is this roller that becomes a pneumatic tired trailer by simply lifting the tongue. Excellent for maintenance and widely scattered jobs. Built by Wheeled Roller Corp., San Antonio, Tex., and equipped with Firestone Heavy Duty tires.

14 Uses for This:

The grader-planer attachment, illustrated herewith, can be mounted on any grader or motor patrol in half an hour.



The Hargrave Planer Attachment.

It is of especial value in street and highway maintenance work. It planes, smooths and pulverizes; it is quick and economical in preparing for oil application, oil road maintenance, and for dirt and gravel road work. A large folder describing it fully, and giving fourteen specific uses for it in highway work can be obtained from Hargrave Construction Co., Cedar Rapids, Ia.

New Service for Contractors:

The Harnischfeger Corporation of Milwaukee maintains a record of "Certified Operators" of experience and proved ability. To become a P & H "Certified Operator," the first requirement is 5 years' actual experience in operating a P & H machine. In addition, the operator must take and successfully pass with a grade of 80 per cent an examination covering practical operating questions, construction details, and servicing of the machine. His references as to ability, character and personal habits are thoroughly investigated before his certificate is issued and any recommendations made to prospective employers.

Super Pneumatic-Tired Scraper:

The R. G. Le Tourneau Company at Stockton, California, announces a Super-Carryall Scraper of 12 yards capacity. The design of the bowl and apron gives a free disposition of material. In sticky gumbo and mud or where rocks are loaded, a larger throat and higher apron opening assures a free delivery.

Another feature is the use of low pressure tires of large diameter. A drastic change in tire construction by a prominent tire manufacturer has given the Le Tourneau Company twenty-inch air tires suitable for construction work. This idea, pioneered by the Le Tourneau Company will revolutionize the movement of heavy equipment on construction works. It is expected that these tires will soon be standard equipment on all Le Tourneau units.

The weight of the new carrier is 14,050 pounds. Specifications:

Average Capacity (loose material)	12 cubic yards
Size Tractor Required	70 to 80 horsepower
Cutting Blade	¾ x 10 inches x 10 feet
Dimensions of Bowl-Bottom	9 x 10 feet
Height of Bowl Sides	4 feet
Wheelbase	17 feet
Six Pneumatic Tires	13:50 x 20
Wheel Bearings	Oversize Timken
Wheel Axles	4¾ inch alloy steel
Sheave Bearings	High Duty Hyatt

Le Tourneau Pneumatic-Tired Scraper.

Pipe, Cast Iron

407. New 1934 Handbook of Super-detables and data for the water works man on pipe line construction, weights, and dimensions. 40 pages, handy pocket size. United States Pipe & Foundry Co., Burlington, N. J.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Taste and Odor Control

411. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

412. Cliff-Char, a Superior Activated Carbon, for Water Purification. Exceptionally high in phenol adsorption, deodorizing power, taste adsorption, clarifying power. Full information will be sent by Chemical Dept., The Cleveland-Cliffs Iron Co., Union Trust Building, Cleveland, Ohio.

Pumping Engines

413. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Screens, Sewage

417. The simple, automatic Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 350 Madison Ave., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

419. An illustrated booklet showing installations, and complete details regarding the 19 exclusive improvements which are featured in Shevlin Fine Disc Screens will be sent promptly by the Shevlin Engineering Co., Inc., 227 Fulton St., New York, N. Y.

420. A useful new bulletin for all those interested in sewage disposal, describing some of their proven equipment such as self-cleaning bar screens, grit conveyors, sludge collectors and shredders, has just been issued by the Jeffrey Mfg. Co., Columbus, Ohio. Includes diagrams and many illustrations.

Screens

424. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sludge Bed Glass Covers

426. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Main Office, Elizabeth, New Jersey. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Conditioning

382. Full information concerning the experiences in the use of ferric chloride for use in sludge conditioning and in coagulating sewage will be sent promptly by Innis, Speiden & Co., 117 Liberty St., New York, N. Y.

Treatment

429. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

430. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

431. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

433. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

Road and Street Maintenance

Asphalt Heaters

8. Full information concerning their tar and asphalt kettles, surface heaters, oil burners and other road maintenance equipment will be sent promptly on request by Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

200. For general construction and maintenance, the Original Improved "Hot-stuf" Asphalt Heater, an economical oil burning heater. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Bituminous Materials

225. A comprehensive manual on the "Use of Emulsions for Street and Highway Construction and Maintenance," discussing types, uses, relative costs, construction details, etc., will be sent promptly on request by Headley Ashphalt Division, Sinclair Refining Co., P. O. Box 72, Marcus Hook, Penna.

226. "Asphalt Surfacing Materials for Low-Cost Roads" is a handy, 28-page booklet illustrating the many types of road surfaces which may be constructed with Texaco asphalt materials. Well illustrated and contains tables of amounts of stone, sand and asphalt required. Sent promptly by the Texas Company, 135 East 42nd St., New York, N. Y.

227. "Asphalt for Every Purpose," a 44-page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvialithic. 32 excellent illustrations.

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Ave., New York, N. Y.

229A. Surface Treatment Types, Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute, 801 Second Avenue, N. Y. Sent on request.

Snow Removal

345. "Standard and Heavy Duty Reversible Blade Snow Plows for Motor Trucks," a new bulletin just published by the Monarch Mfg. Co., East Front St., Wilmington, Del. Illustrated. Contains complete descriptions and specifications.

349. "The Answer to the Snow Removal Problem." It gives full details of the Frink type S snow plow for trucks. Carl Frink, Mfr. of Clayton, N. Y.

359. Galion Iron Works and Mfg. Co., Galion, Ohio. Details, prices and catalogs of their snow plows adaptable to any make of truck.

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For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

Public Health Service Pulications

July-December, 1933.

The publications listed below, except those marked with an asterisk, are available for free distribution and, as long as the supply lasts, can be obtained by addressing the Surgeon General, United States Public Health Service, Washington, D. C. The publications marked with an asterisk (*) can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices noted. No remittances should be sent to the Public Health Service.

1585. Whole-time county health officers, 1933. July 14, 1933. 9 pages.

1596. Estimation of fluorides in waters. By Elias Elvove. October 6, 1933. 4 pages.

1597. Extent of rural health service in the United States, January 1, 1929-December 31, 1932. October 6, 1933. 17 pages.

*1601. Experimental studies of natural purification in polluted waters. VIII. Dissolved oxygen in the presence of organic matter, hypochlorites, and sulphite wastes. By Emery J. Theriault and Paul D. McNamee. November 10, 1933. 15 pages. 5 cents.

1604. State and insular health authorities, 1933. Directory, with data as to appropriations and publications. December 22, 1933. 17 pages.

Supplements

*108. The sanitary privy. 1933. 45 pages. 10 cents.

Asphalt Road Construction Specifications:

Nine pamphlets are available from the Editor of PUBLIC WORKS covering the construction of asphalt pavements, as follows:

Asphalt macadam surface course.

Asphaltic concrete surface course.

Stone-filled sheet asphalt surface course.

Sheet asphalt binder and surface course.

Asphalt macadam base.

Asphaltic concrete base.

Asphalt surface treatment or retreatment.

Asphaltic road-mix macadam aggregate.

Asphaltic road mix, dense aggregate.

These specifications as they relate to surface treatment and road mix types, show in detail the best low cost road construction practice. Copies of any or of all of these on request.

Watertite Concrete:

How to make watertight concrete; selecting the mix; the water-cement ratio; consistency; quantity of aggregates, making trial batches; mixing and placing; curing. Excellent photographs of the various steps in procedure and of slumps for various uses. A combined water - cement ratio - slump - aggregate chart is reproduced. Free from Editor of PUBLIC WORKS, or from D. S. MacBride, 342 Madison Ave., New York.

Dynamics of Earth and Other Macroscopic Matter:

Bulletin 117, issued by the Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa, is of great interest and value. 151 pages, illustrated. Tunnels, piles, foundations and embankments are discussed and illustrated. The author is John H. Griffith.

New Specifications:

The following federal specifications are on sale by the Superintendent of Documents, Washington, D. C., at five cents each. The symbols given all refer to Section IV (Part 5) of the Federal Standard Stock Catalog.

Asphalt; Cut-Back for Road-Work SS-A-671.

Asphalt; for BuiltUp Roofing, Waterproofing, and Damp-Proofing SS-A-666.

Asphalt-Primer; for Roofing and Waterproofing SS-A-701.

Brick; Sewer, Clay SS-B-691.

Cement; Bituminous, Plastic SS-C-153.

Cement; Silica HH-C-176.

Gratings; Steel (Flooring, Landings, Steps, Etc.), Shore and Marine Use (Except for Naval Vessels) RR-G-661.

NRA Highway Construction Provisions:

A reprint by the American Road Builders' Ass'n, Washington, D. C., of the special provisions for constructing highways and related projects in accordance with the National Industrial Recovery Act, as issued by the Bureau of Public Roads.

Choosing Correct Pumping Equipment

Interesting facts about pumps and about "self-primers." What is suction lift?—an often confusing point made plain. Pump rating capacities and actual capacities, diaphragm and centrifugal. The advantages and disadvantages for various uses of diaphragm and centrifugal pumps. Tables of friction in pipe and through elbows. An excellent little booklet issued by Marlow Pumps, Ridgewood, N. J. Copies free.

Duplex Piston Pumps:

Horizontal duplex piston pumps for handling liquids at pressures up to 250 pounds per sq. in., are described in a bulletin just issued by Worthington Pump and Machinery Corp., Harrison, N. J.

Handy Gate Valve Data:

A very complete booklet, though containing only 8 pages, has been issued by the Western Gas Construction Co., Fort Wayne, Ind. This describes Western AWWA standard gate valves and gives complete data on dimensions for sizes 4" to 48". Ask for Bulletin 306.

A Transparent Waterproofing:

The waterproofing of concrete, brick, stucco, stone and similar surfaces by means of "Klearkote," a transparent waterproofing, is described fully in a bulletin issued by the Johnson-March Corp., 52 Vanderbilt Ave., N. Y.

Speed Prime Pumps:

These pumps are described and tables of pump capacities for various sizes and head are given: 2, 3, 4 and 6-inch pumps. Chain Belt Co., Milwaukee, Wisc.

Magnetic Dip Compass:

A very efficient and handy instrument for locating lost valves, valve boxes, stop boxes, etc., is illustrated and described in a folder issued by W. F. Sprengnether, 14 North Ninth St., St. Louis, Mo.

BOOKS

Highway Design and Construction:

By A. G. Bruce, Senior Highway Engineer, U. S. Bureau of Public Roads. 550 pages; 5¼ x 8¼, flexible; 201 illustrations. International Textbook Co. $4.

Mr. Bruce has divided his book into five major parts. The first deals with highway administration and organization; the locating of highways, and the problems connected therewith; and with the design of roads and surfaces. The second part, covering subgrades and drainage, presents in 103 pages, basic data and up-to-date practice in a particularly excellent way. The section on soil studies will be found of great value to the highway engineer; in the 51 pages of this section are answers to most of the questions that commonly arise.

Low cost road surfaces are treated in Part III, and the higher type pavements in Part IV. Part V is devoted to the very important and interesting subject of highway beautification, and also covers such other subjects as guard rails, estimates, specifications, contracts, cost comparisons, and street cleaning and snow removal.

Written by a man who knows his business, and who knows how to write (Mr. Bruce has contributed some excellent articles to PUBLIC WORKS), this book is, we believe, the best obtainable to-day.

It is also an attractive book. It will slip into the average coat pocket. The cover is flexible, the corners are rounded. The type is larger than that used on this page and is very readable. The illustrations are, for the most part, excellent.

We would rate this a 4-star book.